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ANIMAL INVESTIGATION PROGRAM 1978 ANNUAL REPORT: Nevada Test Site and Vicinity

by

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ABSTRACT

Data are presented from the radioanalyses of tissues collected from cattle, mule deer, desert bighorn sheep, rabbits, golden eagles, and other wildlife that resided on or near the Nevada Test Site during 1978. Routine and special activities of the Animal Investigation Program are also discussed.

Other than the naturally occurring Potassium-40, gamma-emitting radionuclides were detected infrequently with the exception of short-lived radionuclides found in samples from animals collected soon after March 14 (the date of a nuclear test by the People's Republic of China).

Strontium-90 concentrations in bones from deer, cattle, and desert bighorn sheep were consistent with those of recent years. Tritium concentrations were generally within expected environmental limits with the exception of animals exposed to sources of contamination; e.g., drainage ponds from Area 12 tunnels. Plutonium levels in all tissues from all species showed little variation from recent years. However, cattle tissue sampled in the fall were higher than those collected in the spring. Radionuclide tissue concentrations were generally higher in the tissues of animals residing in Area 15 than in similar animals collected from other Nevada Test Site areas.

Hypothetical dose estimates to man were calculated on the basis of the daily consumption of 0.5 kilogram of liver or muscle from animals that contained peak radionuclide levels. The highest postulated dose was 1.4 millirems for tritium in tissues from a mule deer that probably drank from Area 12 drainage ponds. This dose is about 0.3 percent of the 500 millirems per year radiation protection standard for individuals in the general population. All other postulated doses for consumption of the tissue containing other radionuclides are about 0.2 percent or less of the standard.

The movements of 13 mule deer outfitted with collars containing a radio transmitter unit were monitored on a weekly basis. During the winter months, all deer left their summer range on the mesas of the Nevada Test Site and migrated 40 to 60 kilometers south and west to Timber Mountain or south to Shoshone Mountain. Those deer that wintered on Timber Mountain made frequent side trips off the Nevada Test Site in the Beatty Wash area. A deer originally captured in 1977 was killed by hunters approximately 120 kilometers from its capture point.

No gross or microscopic lesions were found in necropsied animals that could be directly attributed to the effects of ionizing radiation.

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INTRODUCTION

The U.S. Environmental Protection Agency's Environmental Monitoring Systems Laboratory* has since 1964, conducted the Animal Investigation Program for the Nevada Operations Office of the U.S. Department of Energy and its predecessor agencies. Previous reports (Fountain 1961; Smith and Giles 1970, 1974, and 1975; Smith et al. 1976, 1977a, 1977b, 1978a, 1978b, and 1979) have detailed the history, evolution, and accomplishments of the Animal Investigation Program since its beginning in 1957. During 1978, the major objectives of this program were:

1. To conduct surveillance of domestic and wild animals on and around the Nevada Test Site (NTS) to assess the radionuclide burden present in their tissues and to detect pathological effects from the burdens.

2. To investigate alleged damage to domestic animals and wildlife resulting from the activities of the Nevada Operations Office of the U.S. Department of Energy.

3. To maintain public information through education and veterinary advice to the offsite population.

4. To conduct special ad hoc investigations.

Progress during 1978 in achieving these objectives and summaries of the data collected are presented in this report.

*Effective June 3, 1979, the Environmental Monitoring and Support Laboratory, Las Vegas, Nevada was designated the Environmental Monitoring Systems Laboratory, Las Vegas, Nevada.

SAMPLE COLLECTION

Nevada Test Site animals sampled during 1978 included cattle, mule deer, rabbits, chukar, eagles, and a feral horse. Desert bighorn sheep that range the mountainous areas to the south and east of the NTS were sampled. The sampling included animals that had died from natural causes or by accident, those collected through the cooperation of licensed hunters, and those that were sacrificed as part of the routine sampling activities of the program.

Sacrificed animals, killed either by rifle or shotgun fire, were usually necropsied immediately after death and any gross pathological conditions noted. Animals collected by other means were also necropsied if a prosector were available. If advanced postmortem changes had not occurred, the adrenals, eyes, heart, kidneys, liver, lungs, muscle, spleen, thyroid, gonads, and gross lesions (if any) were sampled and prepared for histopathological evaluation. If fresh blood were available, heparinized samples were collected for hematological examination. Tissues collected for radioanalysis from large animals included rumen or stomach contents, liver, lungs, tracheobronchial lymph nodes, muscle, thyroids, blood, kidneys, fetus (if present) and bone (femurs or hock). Tissues collected for radioanalyses from small animals (rabbit, chukar, and eagle) included bone from the entire skeleton, muscle, skin, entire gastrointestinal tract, and composited internal organs (liver, lungs, kidneys, and spleen).

Nevada Test Site cattle sampled during the year consisted of 12 animals from the Area 18 beef herd. Five of these animals were sampled in the field following their deaths from respiratory failure associated with improper application of Dichlorvos (Vapona®). Sampling information for all the cattle sampled is presented in Table 1. Each animal sampled spent its entire life, except for a brief weaning period, grazing on the Area 18 range of the Nevada Test Site (Figure 1). The management of the beef herd and soil and range surveys of the Area 18 grazing area have been published previously (Smith 1970, Leavitt 1970, and Brown and Mason 1968).

Tissue samples were collected from five Nevada Test Site adult mule deer (Odocoileus hemionus) and two fetuses. (See Table 2 for sampling information.) All the deer were sampled after being struck by motor vehicles. Ten jackrabbits (Lepus californicus) and three desert cottontails (Sylvilagus audubonii) were collected at the Area 15 experimental farm. Other Nevada Test Site animals included six jackrabbits, one feral horse (Equus chrysaetos), three golden eagles (Aquila chrysaetos), and two chukar (Alectoris chukar). Collection locations are noted on Figure 1.

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TABLE 1. SAMPLING INFORMATION FOR NEVADA TEST SITE CATTLE

Animal Number	Sex	Age (years)	Weight (kg)	Date Sampled	Remarks
1	F	12	400	05/17/78	A lactating cow in good condition*.
2	M	3	469	05/17/78	Steer in good condition*.
3	M	3	480	05/17/78	Steer in good condition*.
4	F	3	400	05/17/78	A lactating cow in good condition*.
5	F	14	384	05/17/78	In fair condition*.
6	F	1 day	30	05/17/78	Newborn calf, in good condition.
7	F	11	500	10/26/78	In good condition.
8	M	6	632	10/26/78	In good condition. Actinobacillosis of left maxilla.
9	F	11	425	10/26/78	In fair condition. Blind in right eye.
10	M	0.5	143	10/26/78	In good condition.
11	M	0.5	193	10/26/78	In good condition. Lesions of traumatic reticulitis present.
12	M	0.5	145	10/26/78	In good condition.

*Animals 1 through 5 died from respiratory failure following their inadvertent spraying with Dichlorvos (Vapona) for ectoparasite control. They were necropsied and sampled in the field. Blood samples were not collected.

Through the cooperation of state and federal wildlife officials and participating hunters, bone samples were collected from 13 mature desert bighorn sheep (Ovis canadensis nelsoni) rams during the annual hunt. Lungs, liver, and muscle tissues from several animals were composited and used for quality assurance samples. The sampling information for these animals is presented in Table 3 and the collection sites are shown in Figure 2. The majority of the animals were collected from Clark County in southern Nevada with five coming from the Desert National Wildlife Range or the Nellis Air Force Range which are contiguous to the Nevada Test Site.

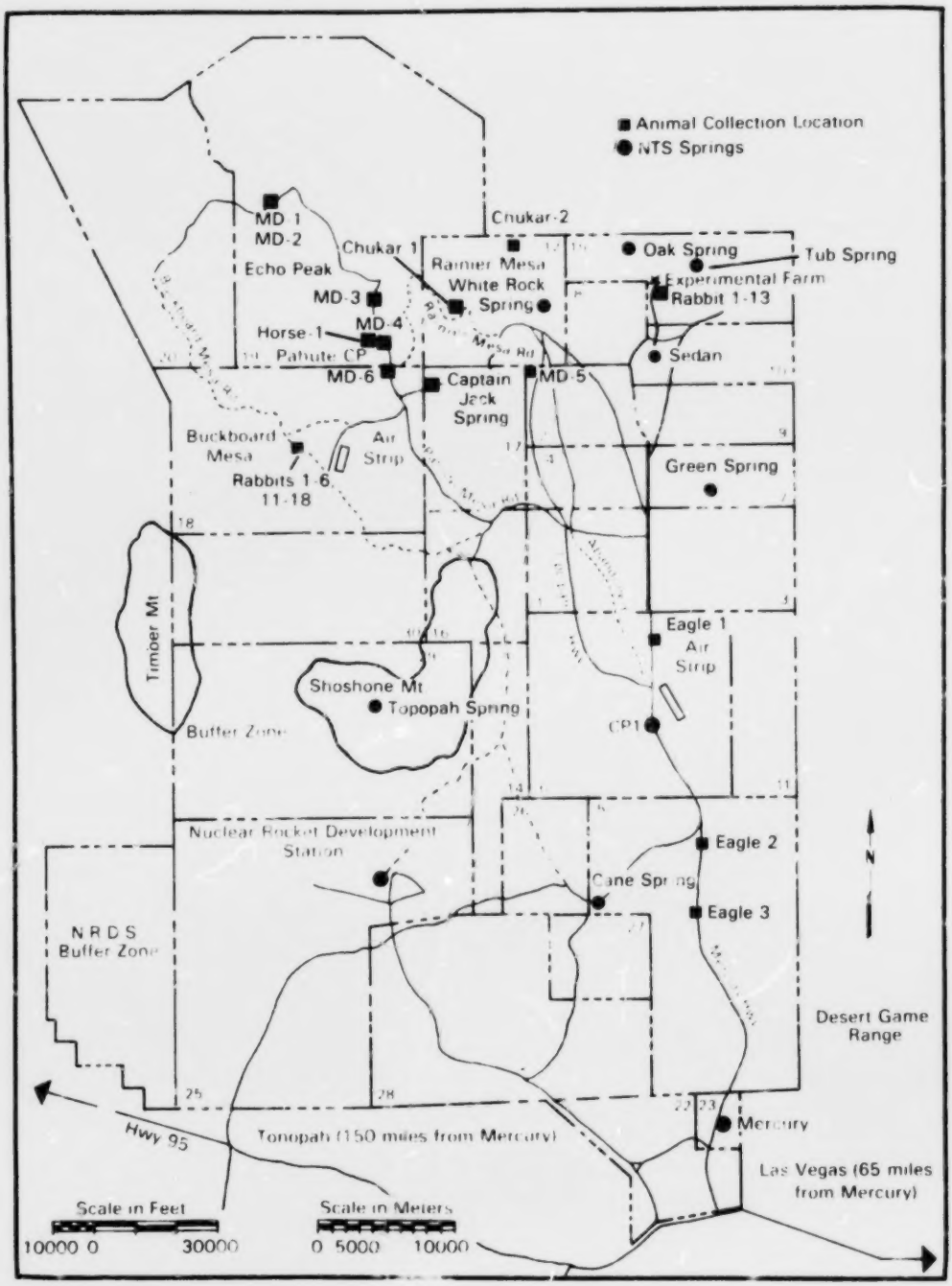

Figure 1. Location of sampling sites on the Nevada Test Site.

TABLE 2. SAMPLING INFORMATION FOR NEVADA TEST SITE WILDLIFE

Animal Number	Sex	Estimated Age	Weight (kg)	Date Collected	Remarks
Mule Deer-1	F	5	70	04/26/78	Accident victim, Area 19, 1 km from first aid station. Pregnant with twin male fetuses.
Mule Deer-2	M	Near term	8	04/26/78	Twin fetuses from Mule Deer-1. Bone, kidney, liver, muscle, and lung samples were composited.
Mule Deer-3	F	Adult	57	05/17/78	Accident victim, Area 18, 1 km north of Camp 17.
Mule Deer-4	M	5	60	07/17/78	Accident victim, Area 18, 1.2 km west of Camp 17.
Mule Deer-5	F	4	55	08/30/78	Accident victim, Area 12, 3.2 km south of Area 12 Camp on Tippipah Highway.
Mule Deer-6	M	1	45	10/04/78	Accident victim, Area 18, 0.7 km west of Area 12 Camp along Pahute Mesa Road.
Horse-1	M	1-2	300	10/09/78	Accident victim, Area 18, 0.7 km north of Area 17 Camp on Pahute Mesa Road.
Rabbit-1-A18	M	Adult	2	03/26/78	Jackrabbit collected, Area 18, on Buckboard Mesa Road by weather radar.
Rabbit-2-A18	F	Adult	2	03/26/78	Jackrabbit collected, Area 18, on Buckboard Mesa Road by airport.
Rabbit-3-A18	F	Adult	2	03/26/78	Jackrabbit collected, Area 18, on Buckboard Mesa Road by airport.
Rabbit-4-A18	F	Adult	2	03/26/78	Jackrabbit collected, Area 18, on Buckboard Mesa Road by turnoff to Scrugham Peak.

(continued)

TABLE 2. (Continued)

Animal Number	Sex	Estimated Age	Weight (kg)	Date Collected	Remarks
Rabbit-5-A18	M	Adult	2	03/26/78	Jackrabbit collected, Area 18, on Airport Road.
Rabbit-6-A18	M	Adult	2	03/26/78	Jackrabbit collected, Area 18, 1 km west of corrals.
Rabbit-1-A15	F	Adult	2	03/09/78	Jackrabbit collected, Area 15, farm along equipment row.
Rabbit-2-A15	F	Juvenile	2	03/09/78	Jackrabbit collected, Area 15, farm microplots.
Rabbit-3-A15	M	Adult	0.7	03/09/78	Cottontail collected, Area 15, farm microplots.
Rabbit-4-A15	M	Adult	0.7	03/09/78	Cottontail collected, Area 15, farm microplots.
Rabbit-5-A15	M	Adult	2	03/09/78	Jackrabbit collected, Area 15, farm reservoir.
Rabbit-6-A15	F	Adult	2	03/09/78	Jackrabbit collected, Area 15, farm reservoir.
Rabbit-7-A15	F	Adult	2	03/09/78	Jackrabbit collected, Area 15, farm reservoir.
Rabbit-8-A15	M	Juvenile	1	03/09/78	Jackrabbit collected, Area 15, east side of alfalfa field.
Rabbit-9-A15	F	Adult	2.1	10/14/78	Jackrabbit collected, Area 15, farm east side of alfalfa field.
Rabbit-10-A15	F	Adult	2.2	10/14/78	Jackrabbit collected, Area 15, farm east side of alfalfa field.
Rabbit-11-A15	M	Adult	2.1	10/14/78	Jackrabbit collected, Area 15, farm east side of alfalfa field.
Rabbit-12-A15	M	Adult	0.62	10/14/78	Cottontail collected, Area 15, farm east side of alfalfa field.

(continued)

TABLE 2. (Continued)

Animal Number	Sex	Estimated Age	Weight (kg)	Date Collected	Remarks
Rabbit-13-A15	M	Adult	1.7	10/14/78	Jackrabbit collected, Area 15, farm east side of alfalfa field.
Eagle-1	M	Adult	3.2	08/15/78	Electrocuted Well 3 power substation in Area 6.
Eagle-2	F	Adult	3.5	11/20/78	Electrocuted power substation, Mercury Highway and Cane Spring Road.
Eagle-3	M	Adult	3.9	12/11/78	Electrocuted power substation, Area 5.
Chukar-1	F	Adult	0.5	12/12/73	Collected on Holmes Road 3/4 mile from Stockade Wash, Area 12.
Chukar-2	F	Adult	0.8	12/12/78	Collected on Holmes Road above T Tunnel, Area 12.

TABLE 3. SAMPLING INFORMATION FOR DESERT BIGHORN SHEEP

Animal No.	Se	Estimated Age (years)	Date Collected	Samples Collected	Remarks
1	M	10	12/19/78	bone	Hunter kill, 3 miles south of Quartz Mountain, Pintwater Range, Area 74*.
2	M	4	11/26/78	bone	Hunter kill, White Rock Spring, Desert National Wildlife Range (DNWR), Area 73.
3	M	6	11/26/78	bone	Hunter kill, Grapevine Spring, DNWR, Area 76*.
4	M	6	11/03/78	bone	Hunter kill, near Sheep Pass, Area 76*.
5	M	7	11/21/78	bone	Hunter kill, eastern edge of Area 80* near burn.
6	M	7	11/26/78	bone	Hunter kill, Echo Wash Peak, Black Mountains, Area 81*.
7	M	6	12/05/78	bone	Hunter kill, Echo Wash, Black Mountains, Area 81*.
8	M	8	12/11/78	bone	Hunter kill, Devil's Peak, Spring Range, Area 83*.
9	M	4	11/25/78	bone	Hunter kill, Highland Guzzler, Highland Range, Area 84*.
10	M	7	11/26/78	bone	Hunter kill, Forlorn Hope, Eldorado Mountains, Area 85*.
11	M	7	11/30/78	bone	Hunter kill, Monkey Wash, Eldorado Mountains, Area 85*.
12	M	5	11/25/78	bone	Hunter kill, 2 miles north of Gunsight, Las Vegas Range, DNWR, Area 78.
13	M	8	12/03/78	bone	Hunter kill, Fossil Ridge, DNWR, Area 78*.
14	M		11/14/78	lung, liver, and muscle.	Composite samples used for quality assurance.
15	M		11/14/78	lung, liver, and muscle.	Composite samples used for quality assurance.

*Nevada Department of Fish and Game Bighorn Sheep Management Area
DNWR = Desert National Wildlife Range

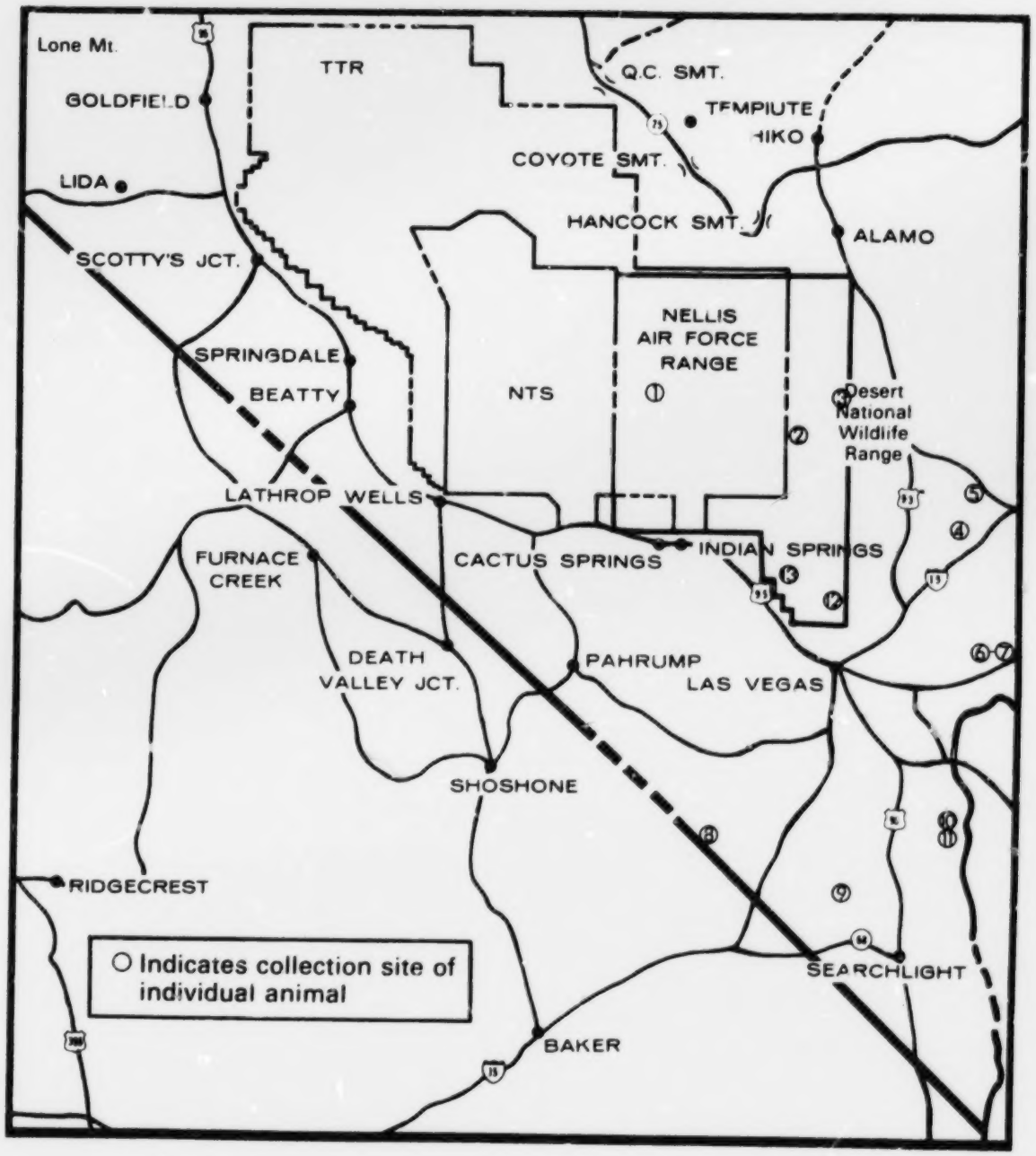

Figure 2. Approximate collection sites of 1978 desert bighorn sheep.

ANALYTICAL PROCEDURES AND METHODS

Samples of soft tissues and rumen contents were analyzed by gamma spectrometry. A sample of blood or tissue was collected from each animal and analyzed for tritium. The bone was analyzed for Strontium-89 and -90 and Plutonium-238 and -239. Selected soft tissues were also analyzed for plutonium content. All of the analyses for tritium, the gamma-emitting radionuclides, and most of the strontium analyses were performed by the Environmental Monitoring Systems Laboratory--Las Vegas (EMSL-LV). The plutonium analyses and a portion of the strontium analyses were performed at the Albuquerque Laboratory of the Eberline Instrument Corporation (EIC).

Rumen contents and soft tissues of sufficient volume were placed in 300-milliliter aluminum containers with a 10-percent Formalin solution as a preservative. The containers were then sealed and stored for gamma analysis. Those of smaller volume, i.e., thyroid gland, tracheobronchial lymph nodes, etc., were first macerated in a blender, then brought to volume by suspending in agar. These samples were also sealed in 300-milliliter aluminum containers. Muscle, liver, lungs, kidneys, and fetal samples were counted for approximately 1,200 minutes on lithium-drifted germanium detectors calibrated at approximately 0.5 kiloelectronvolts per channel in the 60-kiloelectronvolts to 2-megaelectronvolts range. These detectors are connected to a Nuclear Data 6620 computerized gamma spectral accumulation and analysis system. Other tissue samples such as thyroids, tracheobronchial lymph nodes, skin, and gonads, as well as rumen or stomach and gastrointestinal contents, were analyzed for 1,000 minutes on a 4- by 4-inch NaI (Tl) crystal also connected to the Nuclear Data 6620 for spectral accumulation. The spectrometer is calibrated at 10 kiloelectronvolts per channel in the 60-kiloelectronvolt to 2-megaelectronvolt range. The data reduction of the spectra was performed using a least squares program resident on a CDC-6400 computer.

Tissues for strontium and plutonium analyses were prepared by ashing. Plutonium was analyzed by alpha spectrometry using plutonium-236 as an internal tracer. Details of these analytical procedures have been published by Talvitie 1971, 1972; Wish and Rowell 1956; Mitchell 1960; Hagan and Arrhenius 1963; and Major et al. 1975. Other radionuclide analytical procedures used at the EMSL-LV were described previously (Johns 1979).

All data are reported at the 95 percent confidence level counting error and are corrected to time of sample collection. The minimum detectable activity is defined as the 1 sigma counting error times 3.29. Results which show a net sample activity less than the MDA are reported as such. The approximate minimum detectable activities and analytical procedures are summarized in Appendix A.

The activity values for Plutonium-239 listed in this report are actually the sum of the individual isotopic activities of Plutonium-239 and -240. The alpha emissions of these two isotopes cannot be separately identified (resolved) by alpha spectrometric analysis.

Quality assurance samples were included in each group of samples submitted for plutonium analyses. These were either duplicate samples collected from sacrificed animals and submitted under a blind identification number or similar tissue samples purchased at a local market and to which a known amount of plutonium was added. The data from the former type of quality assurance samples are included in the data tables of the Appendices while the data from the spiked samples are presented in Appendix B.

Tissue and lesion samples collected for histopathological examination were fixed with a 10-percent Formalin solution and delivered to a pathologist for interpretation.

When fresh blood was available, 2 milliliters were withdrawn from the juglar vein and placed in a heparinized tube, and two blood-smear slides were made. These were delivered to the Reynolds Electrical and Engineering Company, Inc., Mercury, Nevada, where a complete blood-cell count was made.

RESULTS AND DISCUSSION

QUALITY ASSURANCE SAMPLES

Plutonium-238 and -239 analytical data from the duplicate samples (cow number 10 in the tables of Appendix C) are generally in good agreement. There was a wide range (2.2 to 327) in the percent deviations for the Plutonium-239 analyses of the spiked samples listed in Appendix B. However, the 327 percent deviation was for a sample composited from the livers of several desert bighorn sheep. The sample may have contained a burden of Plutonium-239 prior to spiking as the reported value of 1.8 pCi is within the limits of concentrations reported in the livers of desert bighorn sheep sampled during 1977 (Smith et al. 1979). The highest deviation percent of the Plutonium-239 analyses of the remaining quality assurance samples was 58 percent. The quality of all analyses were assumed to be at this level when conclusions were drawn from the data.

NEVADA TEST SITE CATTLE

The analytical results from tissues collected from the Area 18 beef cattle are presented in the tables of Appendix C.

The naturally occurring Potassium-40 was the only gamma-emitting radionuclide consistently detected in both the May and October samples. Cesium-137 was occasionally detected in the ingesta or soft tissue samples. Zirconium-95 and Cerium-144 were detected in the May ingesta samples. Detectable levels of Iodine-131 were consistently found in the thyroids collected in May. The presence of Iodine-131, Zirconium-95 and Cerium-144 in ingesta and soft tissue samples collected in May are believed to result from the fallout from an atmospheric nuclear test conducted by the People's Republic of China on March 14, 1978.

Tritium was detected in only one beef animal. A concentration of 580 ± 250 picocuries of tritium per liter of tissue water was measured in the kidney of this animal sacrificed in May. This level falls within the range of <300 to 1,900 picocuries per liter of atmospheric moisture (average of <300 pCi/l) found in air samples collected at Beatty, Nevada for the Noble Gas and Tritium Surveillance Network (Nuclear Radiation Assessment Division, 1979).

Strontium-90 concentrations in the femur samples from the Area 18 cattle ranged from 2.4 to 9.2 picocuries per gram of ash with an average of 4.1. As shown in Figure 3, this value is consistent with those of recent years. Strontium-89 was not detected in any of the animals' femurs.

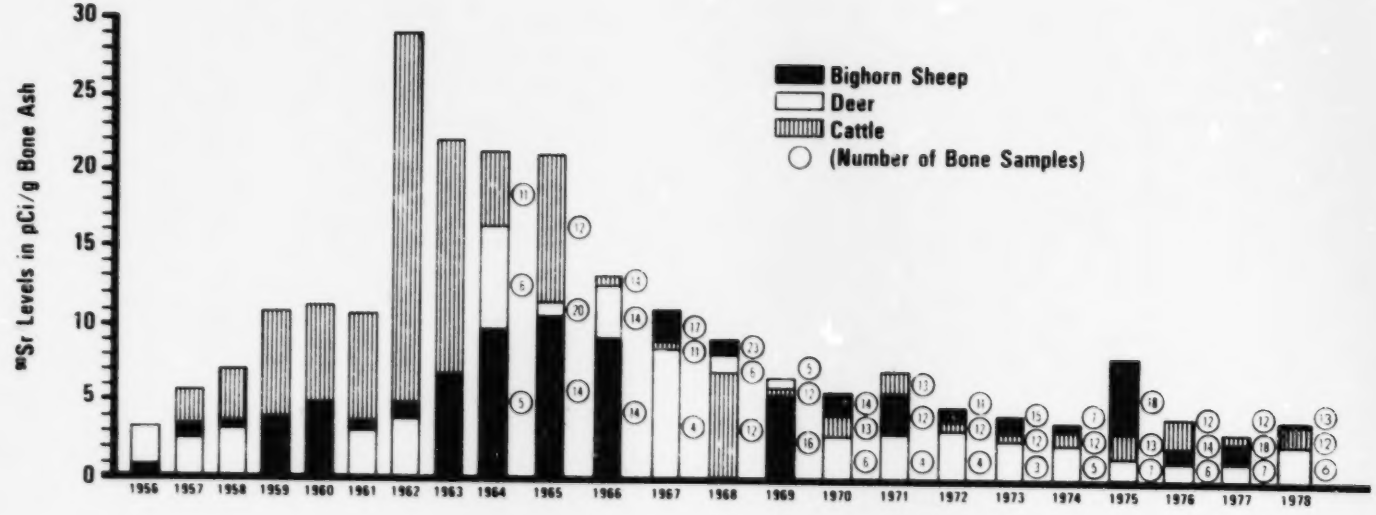

Figure 3. Annual averages of ^{90}Sr in bones of cattle, deer and desert bighorn sheep 1956-1978.

Plutonium-238 is present in the environment primarily as a result of the burnup of a SNAP-9-A power source (Krey and Krajewski 1972; Hardy et al. 1972). The expected ratio of Plutonium-239 to Plutonium-238 is roughly 25. However, this expected ratio is seldom reached in the animal tissues listed in the appendices of this report. The ratios present are quite variable, but generally range between 1 and 5. It has been postulated (Patterson et al. 1974; and Matlock et al. 1976) that Plutonium-238 may be more rapidly solubilized and thus potentially more mobile under environmental conditions than is Plutonium-239. Thus, it is possible that the Plutonium 239:238 ratios for animal tissue may be lower than the ratios for fallout and soil.

The median concentrations of plutonium from the tables in Appendix C are summarized in Table 4. As in previous years (1973 through 1977), increased plutonium activity was noted in the lungs sampled in the fall. It is postulated that the increases are related to range conditions at that time of the year, i.e. forage is scant and dry and more soil is probably ingested and inhaled during the grazing process.

TABLE 4. MEDIAN PLUTONIUM CONCENTRATIONS IN SELECTED TISSUES FROM NEVADA TEST SITE BEEF CATTLE (pCi/kg wet weight)

Tissue	Plutonium-238		Plutonium-239	
	May	October	May	October
Lungs	<1.1	<0.53	<1.1	1.7
Tracheobronchial lymph nodes	NS	<3	NS	13
Muscles	<1.2	<0.49	<1.2	<0.5
Livers	<0.94	<0.52	<0.94	<0.62
Rumen contents	0.82	NS	2.5	NS
Femurs	<4.6	<1.1	<4.6	1.8

NS = Not Sampled

Plutonium-239 was detected in the gonads of only one of the NTS beef animals. Through the cooperation of the University of Nevada, Reno, gonad samples were collected from cattle raised in northern Nevada (Table 5). Again plutonium was infrequently detected. However, positive Plutonium-238 values were reported from the ovaries of two cows. These data are suspect because the sample size was small, ash percentage was high and Plutonium-239 was not detected.

TABLE 5. PLUTONIUM CONCENTRATIONS IN GONADS COLLECTED FROM CATTLE BORN AND RAISED IN NORTHERN NEVADA

Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)	Sex	Age	County
835	<0.02 <0.96	<0.02 <0.96	4.8	M	1	Washoe
839	<0.02 <0.87	<0.02 <0.87	4.4	M	1	Washoe
836	<0.02 <0.84	<0.02 <0.84	4.2	M	1	Washoe
838	<0.02 <0.83	0.02 ± 0.01 0.83 ± 0.42	4.2	M	1	Washoe
844	<0.02 <0.81	<0.02 <0.91	4.6	M	1	Washoe
709	0.02 ± 0.01 1.2 ± 0.58	<0.02 <1.2	5.8	F	8	Washoe
33	<0.02 <1.1	<0.02 <1.1	5.3	F	4	Washoe
3001	<0.03 <2.1	<0.02 <1.4	7.0	F	3	Washoe
233	<0.02 <1.4	<0.02 <1.4	6.7	F	3	Washoe
39	0.05 ± 0.03 2.5 ± 1.5	<0.02 <1.0	5.1	F	3	Eureka
Median	<0.02 <0.99	<0.02 <0.96	5			
Range	0.019-0.05 <0.81-2.5	<0.19-0.02 0.83-<1.4	4.2- 7			

*Wet weight

NEVADA TEST SITE MULE DEER

The analytical results from tissues of the Nevada Test Site mule deer are presented in the tables of Appendix D. As was the case for the Nevada Test Site cattle, the naturally occurring Potassium-40 was the only gamma-emitting radionuclide that was consistently detected. Detectable levels of Cesium-137 were occasionally found in the rumen contents and soft tissue samples. The highest level reported was 70 pCi/kg in muscle tissue collected from deer number three. Zirconium-95 and Cerium-144 were found only in rumen content samples.

A deer sacrificed in April had detectable levels of Iodine-131 (7.5 ± 2.3 picocuries/gram) in its thyroid. The source of this radionuclide is thought to be the atmospheric nuclear test conducted by the People's Republic of China on March 14. Beryllium-7 was reported in the rumen contents of animal number six. Although undetected in samples collected in previous years, Beryllium-7 is a naturally occurring radionuclide that is produced by cosmic radiation.

Tritium levels were elevated in the aqueous portion of the kidney tissue from number six which was sampled near Area 12. This animal had levels of 77,000 picocuries/liter. The source of this tritium is thought to be the waters that drain from the tunnel test area of Rainier Mesa.

The average Strontium-90 level in bone ash from the Nevada Test Site deer was 2.6 picocuries/gram which is similar to levels reported in recent years (Figure 3). Strontium-89 was not detected in any of the bone samples analyzed.

Although plutonium was occasionally detected in the tissues sampled (Appendix D-1), most of the median values reported (Table 6) were below the minimum detectable limits. Positive values were similar to those reported in recent years. Plutonium was not detected in any of the gonad samples.

TABLE 6. MEDIAN PLUTONIUM CONCENTRATIONS IN NEVADA TEST SITE DEER TISSUES (pCi/kg wet weight)

Tissue	^{238}Pu	^{239}Pu
Lungs	<0.53	<0.98
Muscle	<0.62	<1.1
Liver	<0.95	<1.3
Rumen contents	<0.67	<0.7
Bone	<2.0	<2.0
Gonads	<0.5	<0.5

DESERT BIGHORN SHEEP

Bone samples were collected from desert bighorn sheep through the cooperation of licensed hunters. Analytical data are listed in Appendix E. The average Strontium-90 concentration in the hock bones was 4.5 picocuries per gram of ash (Figure 3). Strontium-89 was not detected. Plutonium-239 with a range of 2.7 to 13 pCi/kg wet weight was detected in the bones of only four sheep. Three of the four positive samples were collected from areas to the east of the Nevada Test Site.

NEVADA TEST SITE RABBITS

Area 18 Rabbits

In March, six Area 18 jackrabbits were collected and selected tissues sampled. The analytical data are presented in the tables of Appendix G.

Concentrations of most gamma-emitting radionuclides (Potassium-40, Cesium-137, Cerium-144, and Zirconium-95) detected were of similar magnitude to those found in corresponding tissues collected from the beef cattle which also graze this area. Beryllium-7 was detected in the ingesta of three of the rabbits and was also found in the ingesta of one of the mule deer.

Tritium levels (ranging from <390 to 540 picocuries per liter) in the aqueous portion of the rabbit muscle tissues were not greatly different from those found in the Area 18 cattle and were considered to be within normal environmental limits. Strontium-90 values ranged from 0.7 to 3.9 picocuries per gram of bone ash with a median value of 1.2 picocuries per gram. Strontium-89 was not detected in the bones of any of the rabbits.

The median values of plutonium in selected tissues are shown in Table 7. Plutonium levels in most tissues were similar to those reported from the beef cattle. However, Plutonium-239 was frequently found in the muscle tissue of the rabbits and was generally absent in the cattle. This may be the result of external contamination introduced by shotgun pellets as the rabbits were collected with a 20-gauge shotgun.

Area 15 Rabbits

Rabbits from the Area 15 experimental farm were collected and sampled in March and October. Analytical data from analysis of their tissues are summarized in the tables of Appendix H.

Similar spectra and concentrations of gamma-emitting radionuclides were observed in the Area 15 rabbit tissues as were found in the Area 18 jackrabbits, except Beryllium-7 was not detected. Tritium concentrations in the aqueous portion of the Area 15 rabbit tissues were generally an order of magnitude greater with a median value of 6,400 picocuries per liter and a range of 2,300 to 14,000 picocuries per liter.

TABLE 7. MEDIAN PLUTONIUM CONCENTRATIONS IN NEVADA TEST SITE RABBIT TISSUES (pCi/kg wet weight)

Tissue	Area 18		Area 15	
	^{238}Pu	^{239}Pu	^{238}Pu	^{239}Pu
Muscles	<0.58	0.76 ± 0.61	<0.62	1.5 ± 0.49
Internal organs	<0.55	2.7 ± 0.55	<0.67	3.6 ± 0.89
G.I. tract	<0.72	1.2 ± 1.2	3.7 ± 0.9	54 ± 6.0
Skin	<1.2	4.2 ± 1.9	1.8 ± 0.88	15 ± 8.1
Bone	<2.1	<2.1	<0.89	<1.5

Strontium-90 values ranged from 2.0 to 13 picocuries per gram of bone ash with a median value of 4.8 picocuries per gram. Strontium-89 was detected in one rabbit bone (3.9 ± 1.5 pCi/g of ash).

Table 7 presents the median values of plutonium in selected tissues. Plutonium concentrations in the bones, muscles, and internal organs were similar to those from the Area 18 rabbits. However, the levels in tissues subject to environmental contamination (skin and gastrointestinal tract) were greatly elevated in animals from Area 15.

These findings and those noted for Area 15 animals in previous reports (Smith et al. 1977b, 1978a, 1978b, and 1979) indicate that the environs of Area 15 contain elevated levels of tritium and plutonium when compared to other Nevada Test Site areas that are frequently sampled by the Animal Investigation Program.

NEVADA TEST SITE CHUKARS

Two Area 12 chukars were collected and sampled in December. The data from their tissues are reported in Appendix H. Detectable levels of tritium were found in the aqueous portion of each bird's muscle tissue (1,500 and 700 picocuries per liter, respectively). The bone ash from the birds contained 6.3 and 13 picocuries of Strontium-90 per gram of ash, respectively.

Plutonium-239 was found in the ingesta and internal organs of both birds. The levels of chukar number one were five times greater than those in chukar number two. However, this ratio was reversed in the bones as bone ash from chukar number one contained 3.4 pCi/g ash and that from chukar number two contained 13 pCi/g ash.

NEVADA TEST SITE EAGLES

Three golden eagles were electrocuted at various NTS power substations. Their bodies were sampled and the data are presented in Appendix I. No unexpected radionuclides were detected and the levels were generally similar to those found in previous years (Smith et al. 1979). However, the aqueous portion of the muscle from eagle number two contained 47,000 ± 813 picocuries of tritium per liter. The source of this tritium is unknown. Strontium-90 levels in the bone ash were one-third to one-fourth lower than that in the chukars and ranged from 1.9 to [illegible] picocuries per gram. Plutonium-239 levels in the eagle's bones, ingesta and internal organs were also several fold lower than in the chukar.

NEVADA TEST SITE FERAL HORSE

In November, a feral horse was struck by a vehicle on the Pahute Mesa Road in Area 18. This animal was necropsied and tissue samples were collected. The analytical data from these samples are listed in Appendix J.

Levels of tritium and of gamma-emitting radionuclides detected in the horse's tissue were similar to that found in Area 18 cattle. The bone ash contained 9.4 picocuries of Strontium-90 per gram which was generally a factor of two higher than levels found in bones from the Area 18 cattle. Strontium-90 levels in a horse sampled during 1977 also exceeded those found in the beef cattle (Smith et al. 1979).

Detectable levels of Plutonium-239 were found in the horse's liver, lung, and bone tissues. However, these values were similar to those detected in cattle tissues.

NEVADA TEST SITE WATERS

Several natural springs that serve as a source of water for wildlife were sampled during 1978. These waters were analyzed for gamma-emitting radionuclides and tritium. The analytical results are presented in Table 8. Detectable levels of tritium and gamma-emitting radionuclides other than naturally occurring Potassium-40 were not observed in any of the spring waters. Spring locations are shown in Figure 1.

NECROPSY AND HISTOPATHOLOGICAL EXAMINATIONS

All sacrificed animals were necropsied and selected tissue and lesion samples were collected for histopathological evaluation. The gross and microscopic pathology observed are summarized in Appendix K. Also included in this appendix are the results of hematology examinations when performed. Blood samples from cattle were collected prior to death.

As in previous years, sarcocysts were frequently detected in cattle and deer cardiac and skeletal muscle tissues. This is a ubiquitous parasite of

TABLE 8. TRITIUM AND GAMMA ANALYSIS OF SPRING WATERS, NEVADA TEST SITE

Spring Name	Date Sampled	K (g/kg)	^{3}H (pCi/l)
Cane	05/11	<MDA	<390
Captain Jack	05/10	<MDA	<390
Green	05/10	4.4 ± 0.52	<390
South Kawich	05/10	<MDA	<390
Tippipah	05/10	<MDA	<390
Topopah	05/10	5.3 ± 0.47	<390
Tub	05/11	5.0 ± 0.48	<390
White Rock	05/11	4.9 ± 0.47	<390

<MD = Less than minimum detectable activity

both warm- and cold-blooded vertebrates and is considered to have little clinical significance (Merck and Company 1973).

The incidence of other clinical conditions encountered in beef animals, traumatic reticulitis (number 11), actinobacillosis (number 8), and ocular squamous cell carcinoma (number 9), was felt to be within normal limits for the populations examined. Occasionally observed histologic findings; e.g., hemosiderosis of the spleen, mild kidney changes, and congestion of adrenal cortical sinusoids, were felt to be within normal levels by the examining pathologist. No pathology, gross or microscopic, was observed that could be directly attributed to ionizing radiation.

It was particularly noteworthy that there were so few lesions, either gross or microscopic, associated with the cattle deaths caused by overexposure to dichlorvous. The only consistent lesion noted was mild emphysema of the lungs. Radeleff (1964) states that lesions are sparce in dichlorvous deaths as the very rapid course of poisoning does not permit the development of significant pathology.

HYPOTHETICAL DOSE ESTIMATES

Although meat from animals living on the Nevada Test Site is not available for consumption by the general public, the various doses to a standard man

based on postulated consumption of the edible tissues has been calculated. The dose estimates are not presented as an implication of potential doses, but rather to place the reported radionuclide concentrations in perspective. The dose estimates are based on the techniques and parameters of the International Commission for Radiation Protection (1959, 1968) and Dillman (1969). The estimates were calculated using the maximum observed concentrations of the radionuclides in edible tissues of the cattle and deer sampled (summarized in Table 9), and the postulated consumption of 500 grams (about 1 pound) of the meat each day for a year. The minimum detectable values of Table 9 were used in the dose calculations when they were the maximum value for a given tissue.

The International Commission for Radiation Protection (1959) and the U.S. Department of Energy (1977) present different dose criteria for various parts of the body, based on estimates of relative radiosensitivity. The National Council on Radiation Protection and Measurements (1971) recognizes this philosophy, but recommends simplifying the guides for the general population, and uses the minimum guide (0.5 rem per year to the whole body for an individual in an uncontrolled area) for all body organs. The National Council on Radiation Protection and Measurements emphasizes that this is a simplifying administrative decision, rather than a reduction of the guides based on new technical information.

Table 9 presents a summary of the maximum observed concentrations in selected tissues of the animals. The indicated error terms are the two-sigma counting errors. The total analytical errors or uncertainties (two-sigma) for the plutonium results are estimated to be about 200 femtocuries per kilogram for results of several hundred femtocuries per kilogram, or several times the indicated counting errors. Thus, differences between values, when the values are under several hundred femtocuries per kilogram, have limited statistical significance given the total analytical uncertainties of the results.

Table 10 indicates postulated doses based on the data for maximum concentrations for the various nuclides summarized in Table 9. The column on the right indicates the respective fraction of the radiation protection guide of 500 millirems per year for the various postulated doses. The doses from plutonium and, to a lesser extent, Cesium-137, are not delivered in 1 year. For practical purposes, however, the integrated doses for a 1-year ingestion period are related to the yearly guide.

The highest postulated dose, 1.4 millirems, would result from ingesting deer meat and is based on the assumption that the tritium concentrations in the animal's muscle could be similar to that detected in the kidney. This dose is 0.3 percent of the guide of 500 millirems per year. All of the other postulated doses are about 1 millirem or less and are similar to those estimated for 1976 and 1977 (Smith et al. 1978b, and 1979).

TABLE 9. SUMMARY OF PEAK RADIONUCLIDE CONCENTRATIONS IN SELECTED TISSUES FROM NEVADA TEST SITE ANIMALS

Nuclide	Area 18 Cattle, May 1978				Area 18 Cattle, October 1978			
	Muscle (pCi/kg)	Liver (pCi/kg)	Thyroid (pCi/g)	Kidney (pCi/l)	Muscle (pCi/kg)	Liver (pCi/kg)	Thyroid (pCi/g)	Blood (pCi/l)
^{131}I	<MDA	<MDA	6.0 ± 0.88	NA	<MDA	<MDA	<MDA	NA
^{238}Pu	0.94 ± 0.47	1.6 ± 0.4	NA	NA	<1.3	<0.62	NA	NA
^{239}Pu	1.0 ± 0.51	2.4 ± 0.8	NA	NA	<1.3	6.9 ± 1.2	NA	NA
^{137}Cs	90 ± 28	26 ± 12	NA	NA	71 ± 13	<MDA	NA	NA
^{95}Zr	<MDA	<MDA	NA	NA	<MDA	<MDA	NA	NA
^{3}H	NA	NA	NA	580 ± 250	NA	NA	NA	<420

Nuclide	NTS Mule Deer, 1978				NTS Chukar, 1978
	Muscle (pCi/kg)	Liver (pCi/g)	Thyroid (pCi/g)	Kidney (nCi/l)	Muscle (pCi/kg)
^{131}I	<MDA	<MDA	7.5 ± 2.3	NA	<MDA
^{238}Pu	1.2 ± 0.61	4.1 ± 0.9	NA	NA	<0.5
^{239}Pu	2.9 ± 1.1	1.8 ± 0.5	NA	NA	<0.67
^{137}Cs	74 ± 29	31 ± 13	NA	NA	41 ± 18
^{95}Zr	<MDA	<MDA	NA	NA	<MDA
^{3}H	NA	NA	NA	77.0 ± 1.0	*1.5 ± 0.37

<MDA = Less than minimum detectable activity
NA = Not analyzed
* = pCi/l

TABLE 10. POSTULATED DOSE TO MAN FOLLOWING INGESTION OF SELECTED TISSUES FOR 1 YEAR

Nuclide	Human Organ for which Dose was Calculated	Animal Tissue Containing Maximum Concentration	pCi/kg of Tissue	Dose Factor mrem:pCi/day (1-year Ingestion)*	Dose (mrem)	Percent (0.5 rem)
^{3}H†	Body water	NTS mule deer, kidney	77,000‡	3.6×10^{-5}	1.4	0.3
^{137}Cs	Whole body tissue	Area 18, cattle, muscle	90 ± 28	0.022	0.99	0.2
^{238}Pu	Bone	NTS mule deer, liver	4.1 ± 0.9	0.27	0.55	0.1
^{239}Pu	Bone	Area 18, cattle, liver	6.9 ± 1.2	0.32	1.1	0.2

*The doses from Plutonium-238 and -239, and to a lesser extent Cesium-137, are not delivered within the 1-year ingestion period, but, for simplification, the doses have been related to the guide for 1 year. The doses for plutonium are actually for a 50-year period resulting from ingestion over a 1-year period.
†The tritium concentration was for kidney. It is assumed the muscle concentration (water plus organic) was equal to that of the kidney.
‡pCi/liter

OTHER ACTIVITIES

DEER MIGRATION STUDY

During the summer and fall months, August through November 1978, a total of 19 Nevada Test Site mule deer (Odocoileus hemionus) was captured (Table 11) either by chemical restraint of free-ranging animals (Smith et al. 1978a) or by trapping (Giles 1979). Ten of these deer were outfitted with collars containing new radio transmitters, ear tags, and reflective numbers. Three deer were outfitted with reconditioned radio transmitter collars that had been recovered from previously marked deer. Visual markers (ear tags and reflective collars) were placed on the remaining six captured deer.

Seven of the deer were captured at the Area 19 trapsite and immobilized with M-99 (etorphine). The other 12 deer were captured with a Cap Chur gun (Palmer Chemical Company) and immobilized with Sernylan (phencyclidine hydrochloride), and acepromazine maleate (Ayerest Laboratories, Inc.).

Three of the 19 deer captured died within several weeks of their capture. Two died from accidental falls in steep, rocky terrain, and one was killed by a mountain lion (Felis concolur). Another deer (a doe) was killed by coyotes (Canis latrans) in the 15- to 20-minute time interval between darting the animal with immobilizing drugs and then relocating. This animal was not included in the total number of animals captured because she was never tagged and given an I.D. number.

As shown in Figure 4, the deer captured in Areas 19 and 20 wintered in the Timber Mountain, 40-Mile Canyon, and Yucca Mountains regions with frequent side trips into the Nellis Bombing and Gunnery Range and Beatty Wash areas. An exception was a doe (number 6, white) which wintered over the western boundary of the Nevada Test Site on the Nellis Bombing and Gunnery Range northeast of Beatty, Nevada, between Timber Mountain and Black Mountain.

Deer captured in Area 12 on or near Rainier Mesa wintered on Shoshone Mountain and in Area 30 (Figure 4). In the latter area, there is some mixing of animals from both summer ranges (Pahute and Rainier Mesas). To date there has been very little mixing of animals on the summer ranges. During October of the 1978 hunting season, a deer originally captured on October 26, 1977, was killed by a hunter at the Breen Ranch, south of Kawich Peak. During this 1-year interval, the deer had traveled at least 120 kilometers from its capture point to the area where it was killed. The radio transmitter, which was still operating, was recovered and reconditioned for use during 1979.

TABLE 11. 1978 DEER CAPTURED

Animal I.D.	Sex	Age Estimated (years)	Weight Estimated (kg)	Date Captured	Location	Date Death	Location	Recapture	Comments
1-White	M	5-6	47	08/10/78	A-19 Echo Peak traps.			Old No. 1-Blue	Recaptured. Wintered north end of Timber Mountain.
2-White	M	2-3	50	08/09/78	A-20 First Aid Station.				Wintered in 40-Mile Canyon.
3-White	F	4-5	45	08/16/78	A-19 North end of Burn Valley				Lactating female. Wintered on the northeast portion of Timber Mountain.
4-White	M	1-2	48	08/15/78	A-12 Rainier Mesa south end.	09/04/78	Rainier Mesa above G Tunnel.		Accidental death due to fall. Unable to recover radio due to the steep hillside.
5-White	M	2-3	50	08/19/78	A-19 Echo Peak traps.				Wintered on west edge of Timber Mountain and Bombing and Gunnery Range east of Beatty, Nevada.
6-White	F	3-4	46	08/22/78	A-19 1.5 miles northwest of traps on Echo Peak.				Lactating female. Wintered off the Nevada Test Site between Black Mountain and Area 20.
7-White	M	4-5	86	08/23/78	A-12 Rainier Mesa, First Aid Station.				Winter in Area 30 and 40-Mile Canyon area.
8-White	M	2-3	56	08/08/78	A-19 Dead Horse Flat Road by U19e.	08/20/78	3/4 mile north of capture site.		Appeared to be accidental death due to fall in rocks. Radio was recovered.
8-White	M	3-5	65	09/19/78	A-19 Echo Peak traps.				Wintered in Area 30, 40-Mile Canyon and Buggy Site.
9-White	F	3-4	64	09/20/78	A-20 1.5 miles southwest of Camp Site.				Lactating female. Wintered on Timber Mountain.

(continued)

TABLE 11. (Continued)

Animal I.D.	Sex	Age Estimated (years)	Weight Estimated (kg)	Date Captured	Location	Date Death	Location	Recapture	Comments
10-White	M	4-5	85	09/20/78	A-19 Echo Peak traps.				Wintered west of Timber Mountain off the Nevada Test Site. Difficult to track due to few sightings.
4-Blue	F	2-3	45	08/05/78	A-19 Dead Horse Flat Road U19e.	08/10/78	4 miles east of capture site.		Lion kill, confirmed by Nevada Fish and Game personnel, who helped recover the radio.
4-Blue	M	3-4	83	10/04/78	A-19 0.5 mile west of U19as.				Wintered in Yucca Mountains, Beatty Wash area off the Nevada Test Site.
8-Blue	M	1-2	45	08/05/78	A-12 Rainier Mesa north end.				Wintered Area 29 and 14 on Shoshone Mountain east side.
1-Blue	F	4-5	64	10/05/78	A-19 Echo Peak traps.				Wintered Timber Mountain and Bombing and Gunnery Range.
G	M	5-6	100	09/20/78	A-19 Echo Peak traps.				Given ear tags and reflective number. Sighted 09/22/78.
H	F	3-4	48	10/06/78	A-19 Echo Peak turnoff.				Given ear tags and reflective number. Sighted 10/19/78 with one fawn.
I	M	0.25	2	10/24/78	A-19 Echo Peak traps.				A fawn which was given ear tags only.
J	M	1-2	46	11/08/78	A-12 G Tunnel turnoff.				Given ear tags and reflective number.

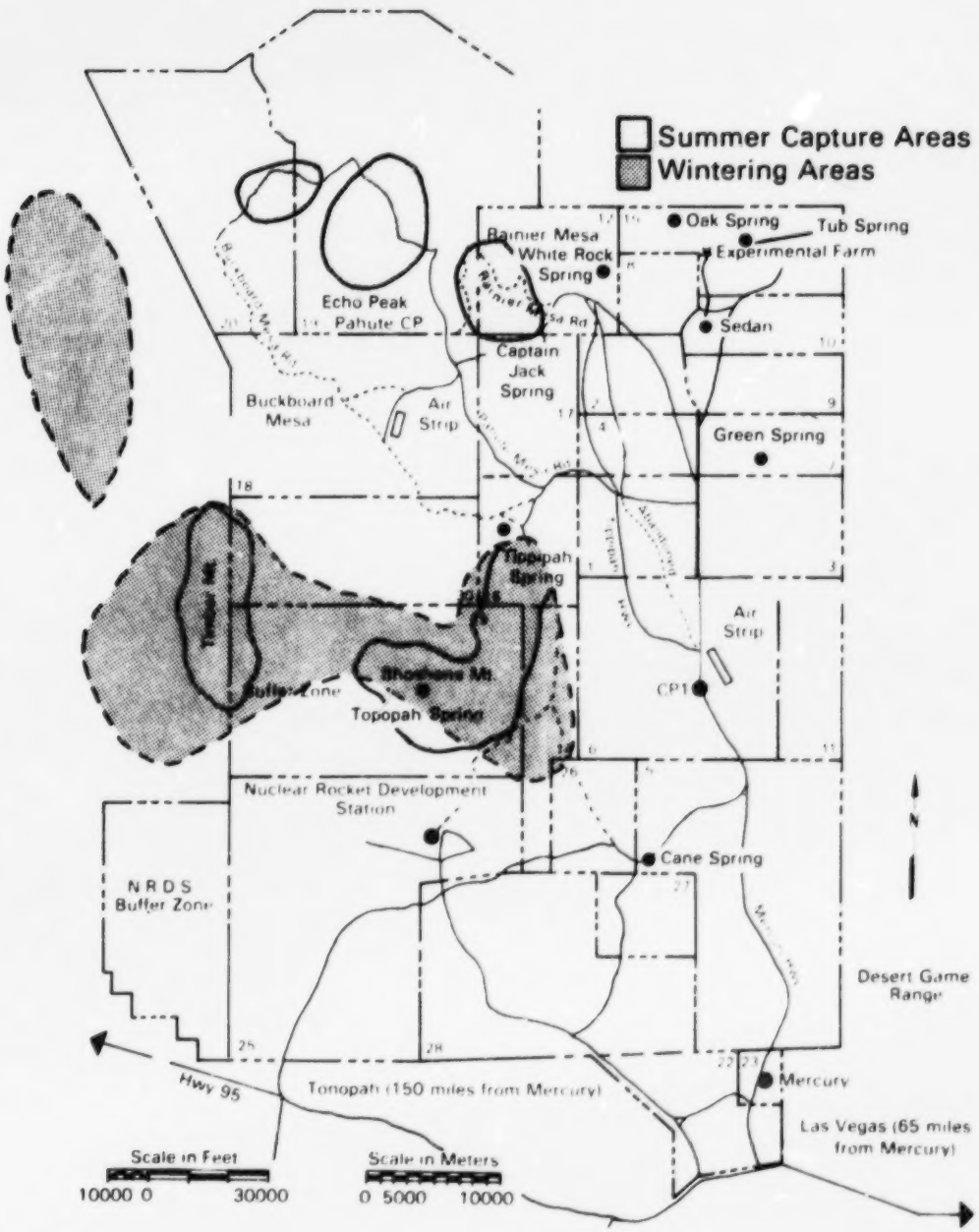

Figure 4. 1978 Mule deer capture and wintering areas.

INVESTIGATIONS AND OTHER PROJECTS

During 1978, there were no livestock damage claims against the U.S. Department of Energy.

The natural springs of the Nevada Test Site were monitored on a periodic basis and repaired or rehabilitated as indicated.

As part of a Nevada Applied Ecology Group sponsored study, the rumen-fistulated steers were grazed on six different Nevada Test Site and Tonopah Test Range nuclear sites. Ingesta samples were collected for botanical and radionuclide analyses. The data from this study will be published at a later date as a Nevada Applied Ecology Group report.

The Nevada Test Site beef herd was reduced to a more manageable size by transferring 40 surplus animals to the University of Nevada, Reno. It is planned to further reduce the herd during 1979 until it numbers approximately 40 animals.

PUBLIC INFORMATION

The offsite public information program continued by direct contact with ranchers, by public displays, by lectures to civic organizations, and by briefings of groups touring the Environmental Monitoring Systems Laboratory--Las Vegas or the Nevada Test Site facilities. During 1978, the objectives and findings of the Animal Investigation Program were presented to 342 Nevada Test Site visitors in 23 different tour groups. Approximately 250 additional casual visitors to the farm received informal briefings. Representatives of United Press International and the Los Angeles Times were also briefed on the Animal Investigation Program's activities.

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TABLE A-1. SUMMARY OF ANALYTICAL PROCEDURES AND MINIMUM DETECTABLE ACTIVITIES

Type of Analysis	Analytical Equipment	Counting Period (min)	Analytical Procedures	Sample Size	Minimum Detectable Activities (pCi/total sample)*
Gamma Spectroscopy	Lithium-drifted germanium detectors calibrated at approximately 0.5 keV per channel input to 4096 channels resident in the core of the Nuclear Data 6620 computer-based gamma spectrometry system.	~1,200	Radionuclide concentrations quantitated from gamma spectrum by Nuclear Data 6520 computer-based gamma spectrometry system using vendor supplied software.	300-ml aluminum cans	For: ^{54}Mn, ^{60}Co, ^{95}Zr, ^{103}Ru, ^{124}Sb, ^{132}Te ^{131}I, ^{134}I, ^{137}Cs, ^{140}Ba - 7 pCi For: ^{125}Sb, ^{141}Cs, - 30 pCi For: ^{65}Zn, ^{106}Ru, ^{144}Ce - 20 pCi For: ^{181}W - 85 pCi
	or by				
	10-cm-thick by 10-cm-diameter NaI (Tl-activated) crystal with input to Nuclear Data 6620 calibrated at 10 keV per channel in the 60 keV to 2 meV range.	1,000	Radionuclide concentration quantitated by CDC-6400 computer using Least Squares Technique.	300-ml aluminum cans	For: ^{241}Am - 35 pCi For: ^{22}Na - 4 pCi For: K - 0.08 g
$^{89-90}Sr$	Low-background thin-window, gas-flow proportional counter with a 5.7-cm diameter window (80 ug/cm^2).	50	Chemical separation by ion exchange. Separated sample counted successively; activity calculated by simultaneous equations.	2 g of ash	For: ^{89}Sr - 5 pCi ^{90}Sr - 3 pCi
^{3}H	Automatic liquid scintillation counter with output printer.	200	Sample prepared by distillation.	5 ml	0.4 pCi/ml H_2O
$^{238-239}Pu$	Alpha spectrometer with silicon surface barrier detectors operated in vacuum chambers.	400-1,400	Ash sample is digested with acid, purified by solvent extraction and/or ion exchange, electroplated on stainless steel planchet, and counted by alpha spectrometer.	100 g - 1 kg wet weight 1 - 10 g of ash	For all isotopes - 0.04 pCi

*The minimum detectable activities in terms of total activity per sample for standard geometries and counting times are defined as those activities which equal 3.29 sigma (counting error) [Environmental Measurements Laboratory (EML-formerly HASL) Procedures Manual, HASL-300, pages D-08-02 through D-08-06, August 1974]. These values are approximations and are applicable to ideal conditions and simple complexes of nuclides. Complex spectra or spectra showing naturally occurring radionuclides can raise the minimum detectable activities considerably. The detection limit for each radionuclide is defined as that radioactivity which equals the 3.29 sigma counting error.

TABLE B-1. PLUTONIUM QUALITY ASSURANCE RESULTS

Tissue Type	Wet Weight (g)	Nuclide	Acitivity Added (pCi/sample)	Activity Reported (pCi/sample)	% Deviation*
Liver†	788	^{239}Pu	0	<0.5	--
		^{238}Pu	2.2	3.0 ± 0.99	36
Liver†	366	^{239}Pu	0.52	0.8 ± 0.4	54
		^{238}Pu	0	<0.2	--
Liver†	586	^{239}Pu	2.1	0.88 ± 0.22	58
		^{238}Pu	0	<0.22	--
Liver†	420	^{239}Pu	5.1	5.0 ± 1.0	2.2
		^{238}Pu	0	<0.25	--
Muscle†	466	^{239}Pu	0	<0.2	--
		^{238}Pu	3.3	2.5 ± 0.39	23
Muscle†	462	^{239}Pu	0.42	0.5 ± 0.25	19
		^{238}Pu	0	<0.25	--
Muscle†	602	^{239}Pu	1.1	1.2 ± 0.29	11
		^{238}Pu	0	0.22	--
Muscle†	717	^{239}Pu	0.74	0.87 ± 0.44	18
		^{238}Pu	0	0.44	--
Muscle‡	248	^{239}Pu	0.28	0.25 ± 0.11	12
		^{238}Pu	0	<0.005	--
Muscle‡	230	^{239}Pu	0.77	0.33 ± 0.13	57
		^{238}Pu	0	<0.03	--
Liver‡	192	^{239}Pu	0.61	3.13 ± 1.2	327
		^{238}Pu	0	1.8 ± 0.82	--
Liver‡	240	^{239}Pu	2.09	2.2 ± 0.45	5
		^{238}Pu	0	<0.099	--
Lung‡	201	^{239}Pu	0.28	0.41 ± 0.19	46
		^{238}Pu	0	<0.068	--
Lung‡	204	^{239}Pu	1.21	0.86 ± 0.23	29
		^{238}Pu	0	<0.66	--

*% deviation = $\frac{x - u}{u} \times 100$ where x = activity reported
u = activity added

†Liver and muscle purchased at local meat market.

‡Lung, liver, and muscle composited from several desert bighorn sheep killed by hunters.

TABLE C-1. PLUTONIUM CONCENTRATIONS IN LUNGS, BEEF CATTLE, AREA 18, NTS, 1978

May 1978				October 1978			
Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)	Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)
1	<0.02 <1.1	0.04 ± 0.01 2.2 ± 0.55	5.5	7	0.01 ± 0.01 0.56 ± 0.56	0.03 ± 0.01 1.7 ± 0.56	5.6
2	<0.02 <1.1	<0.02 <1.1	5.6	8	0.01 ± 0.01 0.50 ± 0.50	0.02 ± 0.01 1.0 ± 0.50	5.0
3	0.02 ± 0.01 1.1 ± 0.54	0.03 ± 0.01 1.6 ± 0.54	5.4	9	0.11 ± 0.02 5.5 ± 1.0	0.42 ± 0.04 21 ± 2.0	5.0
4	<0.02 <1.1	<0.02 <1.1	5.7	10	0.01 ± 0.01 0.48 ± 0.48	0.05 ± 0.01 2.4 ± 0.48	4.8
5	0.02 ± 0.01 0.74 ± 0.37	0.03 ± 0.01 1.1 ± 0.37	3.7	Dupl. 10	0.01 ± 0.01 <0.53	0.04 ± 0.01 2.1 ± 0.53	5.3
6	<0.02 <0.76	<0.02 <0.76	3.8	11	<0.01 <0.49	0.01 ± 0.01 0.49 ± 0.49	4.9
				12	0.01 ± 0.01 0.48 ± 0.48	0.01 ± 0.01 0.48 ± 0.48	4.8
Median	<0.02 <1.085	<0.025 <1.13	5.4	Median	0.01 <0.53	0.03 1.7	5.0
Range	<0.02-<0.02 <0.76-<1.1	<0.02-0.04 <0.76-2.2	3.7-5.7	Range	<0.01-0.11 0.48-5.5	0.01-0.42 0.48-21	4.8-5.6

*Wet weight

TABLE C-2. PLUTONIUM CONCENTRATIONS IN TRACHEOBRONCHIAL LYMPH NODES, BEEF CATTLE, AREA 18, NTS, 1978

May 1978				October 1978			
Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)	Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)
1	Samples not collected			7	0.14 ± 0.09 7.9 ± 5.1	0.41 ± 0.16 23 ± 9.0	5.6
2	Samples not collected			8	0.06 ± 0.04 4.7 ± 3.2	1.4 ± 0.3 110 23	7.9
3	Samples not collected			9	0.58 ± 0.24 36 ± 15	5.5 ± 1.0 340 ± 62	6.2
4	Samples not collected			10	<0.01 <1.07	0.02 ± 0.01 2.1 ± 1.1	11
5	Samples not collected			11	<0.01 <0.69	0.01 ± 0.01 0.69 ± 0.69	6.9
6	Samples not collected			12	<0.01 <1.2	<0.01 <1.2	12
Median				Median	<.04 <3	0.22 13	7.4
Range				Range	<0.01-0.58 0.69-36	<0.01-5.5 0.69-340	5.6-12

*Wet weight

TABLE C-3. PLUTONIUM CONCENTRATIONS IN MUSCLES, BEEF CATTLE, AREA 18, NTS, 1978

May 1978				October 1978			
Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)	Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)
1	<0.02 <1.1	<0.02 <1.1	5.5	7	<0.01 <0.52	<0.01 <0.52	5.2
2	<0.02 <1.0	0.02 ± 0.01 1.0 ± 0.51	5.1	8	<0.01 <0.66	<0.01 <0.66	6.6
3	<0.02 <1.3	<0.02 <1.3	6.3	9	<0.01 <0.47	<0.01 <0.47	4.8
4	<0.02 <1.2	<0.02 <1.2	6.0	Fetus 9	<0.01 <0.43	<0.02 <0.85	4.9
5	<0.02 <1.3	<0.02 <1.3	6.6	10	<0.01 <0.49	<0.01 <0.49	4.6
6	0.02 ± 0.01 0.94 ± 0.47	<0.02 <0.94	4.7	Dupl. 10	<0.01 <0.49	<0.01 <0.49	5.1
				11	<0.01 <0.46	<0.01 <0.46	4.3
				12	<0.01 <0.51	<0.01 <0.51	4.9
Median	<0.02 <1.15	<0.02 <1.15	5.5	Median	<0.01 <0.49	0.01 0.50	4.9
Range	<0.02 0.94-<1.3	<0.02-<0.02 <0.94-<1.3	4.7-6.6	Range	<0.01-<0.01 <0.43-<0.66	<0.01-<0.02 <0.46-<0.85	4.3-6.6

*Wet weight

TABLE C-4. PLUTONIUM CONCENTRATIONS IN LIVERS, BEEF CATTLE, AREA 18, NTS, 1978

May 1978				October 1978			
Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)	Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)
1	0.04 ± 0.01 1.6 ± 0.40	0.06 ± 0.02 2.4 ± 0.8	4.0	7	<0.01 <0.55	0.01 ± 0.01 0.55 ± 0.55	3.5
2	<0.02 <0.63	0.02 ± 0.01 0.63 ± 0.32	3.2	8	<0.01 <0.35	0.02 ± 0.01 0.70 ± 0.35	4.3
3	<0.02 <1.1	0.02 ± 0.01 1.1 ± 0.52	5.3	9	<0.01 <0.43	0.02 ± 0.01 0.86 ± 0.43	1.7
4	<0.02 <0.93	<0.02 <0.93	4.6	10	<0.01 <0.17	0.01 ± 0.01 0.17 ± 0.17	5.2
5	<0.02 <0.93	<0.02 <0.93	4.7	Dupl. 10	<0.01 <0.52	0.01 ± 0.01 0.52 ± 0.52	5.8
6	<0.02 <0.94	<0.02 <0.94	4.7	11	<0.01 <0.58	0.12 ± 0.02 6.9 ± 1.2	6.2
				12	<0.01 <0.62	<0.01 <0.62	5.4
Median	<0.02 <0.94	<0.02 <0.94	4.7	Median	<0.01 <0.52	0.01 <0.62	5.2
Range	<0.02-0.04 <0.63-1.6	<0.02-0.06 <0.63-2.4	3.2-5.3	Range	<0.01-<0.01 <0.17-<0.62	<0.01-0.12 0.17-6.9	1.7-6.2

*Wet weight

TABLE C-5. PLUTONIUM CONCENTRATIONS IN GONADS, BEEF CATTLE, AREA 18, NTS, 1978

May 1978				October 1978			
Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)	Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)
1	<0.02 <1.0	<0.02 <1.0	5.0	7	<0.01 <1.8	<0.01 <1.8	18
2	Sample not collected			8	Sample not collected		
3	Sample not collected			9	<0.01 <1.0	<0.01 <1.0	10
4	<0.10 <4.0	<0.02 <0.81	4.0	10	<0.01 <0.51	0.01 ± 0.01 0.51 ± 0.51	5.1
5	<0.02 <0.01	<0.02 <0.01	0.06	11	<0.01 <0.48	<0.01 <0.48	4.8
6	Sample not collected			12	<0.01 <0.31	<0.01 <0.31	3.1
Median	<0.02 <1.0	<0.02 <0.81	4.0	Median	<0.01 <0.51	<0.01 <0.51	5.1
Range	<0.02-<0.10 <0.01-<4.0	<0.02-0.02 <0.01-1.0	0.06-5.0	Range	<0.01-<0.01 <0.31-<1.8	<0.01-0.01 <0.31-<1.8	3.1-18

*Wet weight

TABLE C-6. PLUTONIUM CONCENTRATIONS IN RUMEN CONTENTS, BEEF CATTLE, AREA 18, NTS, 1978

May 1978				October 1978			
Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)	Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)
1	0.02 ± 0.01 0.82 ± 0.41	0.15 ± 0.03 6.1 ± 1.2	4.1		Samples not collected as fed hay		
2	0.05 ± 0.02 1.8 ± 0.72	0.07 ± 0.02 2.5 ± 0.72	3.6		Samples not collected as fed hay		
3	0.44 ± 0.06 8.5 ± 1.2	21 ± 2.0 400 ± 39	1.9		Samples not collected as fed hay		
4	0.03 ± 0.01 0.54 ± 0.18	0.12 ± 0.02 2.2 ± 0.36	1.8		Samples not collected as fed hay		
5	0.02 ± 0.01 0.56 ± 0.28	0.04 ± 0.01 1.1 ± 0.28	2.8		Samples not collected as fed hay		
6	Samples not collected						
Median	0.03 0.82	0.12 2.5	2.8				
Range	0.02-0.44 0.54-8.53	0.04-21 1.1-400	1.8- 4.1				

*Wet weight

TABLE C-7. PLUTONIUM AND STRONTIUM CONCENTRATIONS IN FEMURS, BEEF CATTLE, AREA 18, NTS, MAY 1978

Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	^{89}Sr (pCi/g Ash) (pCi/kg*)	^{90}Sr (pCi/g Ash) (pCi/kg*)	Ash (%)
1	<0.02 <5.8	<0.02 <5.8	<3.1 <890	2.7 ± 0.69 780 ± 200	29
2	<0.02 <4.3	<0.02 <4.3	<1.5 <320	2.4 ± 0.61 600 ± 130	21
3	<0.016 <4.3	<0.016 <4.3	<1.5 <400	3.7 ± 0.76 980 ± 200	26
4	<0.02 <4.8	<0.02 <4.8	<1.5 <370	3 ± 0.71 720 ± 170	24
5	<0.02 <5.1	<0.02 <5.1	<1.6 <400	2.7 ± 0.7 680 ± 186	26
6	<0.02 <2.3	<0.02 <2.3	<1.6 <180	4.6 ± 0.84 520 ± 95	11
Median	<0.02 <4.6	<0.02 <4.6	<1.6 <385	2.85 700	25
Range	<0.016-<0.02 <2.3-<5.8	<0.016-<0.02 <2.3-<5.8	<1.5-<3.1 <180-<890	2.4-4.6 500-980	11-29

*Wet weight

TABLE C-8. PLUTONIUM AND STRONTIUM CONCENTRATIONS IN FEMURS, BEEF CATTLE, AREA 18, NTS, OCTOBER 1978+

Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	^{89}Sr (pCi/g Ash) (pCi/kg*)	^{90}Sr (pCi/g Ash) (pCi/kg*)	Ash (%)
7	<0.004 <1.2	<0.004 <1.2	<27 <8,200	4.1 ± 0.23 1,300 ± 70	31
8	<0.004 <1.1	<0.004 <1.1	<18 <4,900	5.0 ± 0.21 1,400 ± 60	27
9	<0.003 <0.89	0.011 ± 0.007 3.3 ± 2.1	<37 <1,100	9.2 ± 0.2 2,800 ± 60	30
10	<0.005 <1.1	0.008 ± 0.006 1.8 ± 1.3	<17 <3,800	3.7 ± 0.2 810 ± 38	22
Dupl. 10	<0.003 <0.66	0.013 ± 0.007 2.9 ± 1.5	<18 <3,900	5.3 ± 0.21 1,200 ± 50	23
11	<0.005 <1.2	0.008 ± 0.007 1.8 ± 1.6	<15 <3,400	3.5 ± 0.21 800 ± 48	22
12	<0.003 <0.66	<0.003 2.9 ± 1.5	<15 <3,100	3.6 ± 0.21 760 ± 44	22
Median	<0.004 <1.1	<0.006 1.8	<18 <3,900	41 1,200	25
Range	<0.003-<0.005 <0.66-<1.2	<0.003-0.011 <1.1-3.3	<15 - <37 <3,100 - <1,100	3.5 - 9.2 760 - 2,800	22-31

+All analyses by Eberline Instrument Corporation.
*Wet weight

TABLE C-9. GAMMA-EMITTING RADIONUCLIDES AND TRITIUM CONCENTRATIONS IN SELECTED TISSUES, BEEF CATTLLE, AREA 18, MAY 1978

Animal Number	Muscle K (g/kg*) ^{137}Cs (pCi/kg*)	Lungs K (g/kg*)	Liver K (g/kg*) ^{137}Cs (pCi/kg*)	Kidney K (g/kg*) ^{3}H (pCi/l+*)	Rumen Contents K (g/kg*) ^{137}Cs (pCi/kg*) ^{95}Zr (pCi/kg*) ^{144}Ce (pCi/kg*)	Thyroid ^{131}I (pCi/g)
1	8.5 ± 0.56 <MDA	1.8 ± 0.5	2.1 ± 0.22 <MDA	7.1 ± 0.61 <390	4.4 ± 0.41 37 ± 19 <MDA 91 ± 79	1.2 ± 0.34
2	3.4 ± 0.27 <MDA	10 ± 0.88	6.8 ± 0.52 <MDA	7.7 ± 0.64 <390	2 ± 0.38 <MDA 140 ± 21 200 ± 72	2.1 ± 0.45
3	8.0 ± 0.58 <MDA	11 ± 0.7	1.2 ± 0.22 <MDA	6.7 ± 0.53 580 ± 250	1.3 ± 0.41 <MDA 23 ± 20 <MDA	0.91 ± 0.16
4	3.6 ± 0.28 29 ± 14	18 ± 1.5	1.9 ± 0.21 <MDA	7.6 ± 0.63 <390	2.2 ± 0.48 <MDA <MDA 210 ± 94	Sample not collected
5	3.8 ± 0.27 25 ± 11	14 ± 1.1	7.0 ± 0.55 <MDA	1.9 ± 0.23 <390	4.7 ± 0.47 41 ± 22 39 ± 23 180 ± 86	1.6 ± 0.16
6	8.0 ± 0.58 90 ± 28	13 ± 1.1	3.5 ± 0.25 26 ± 12	8.4 ± 0.7 <390	Sample not collected	6.0 ± 0.88
Median	5.9 <MDA	12	2.8 <MDA	7.4 <390	2.2 <MDA 23 180	1.6
Range	3.4-8.5 <MDA-90	1.8-18	1.2-7.0 <MDA-26	1.9-8.4 <390-580	1.3-4.7 <MDA-41 <MDA-140 <MDA-210	0.91-6.0

*Wet weight
+Aqueous portion of kidney

TABLE C-10. GAMMA-EMITTING RADIONUCLIDES AND TRITIUM CONCENTRATIONS IN SELECTED TISSUES, BEEF CATTLE, AREA 18, NTS, OCTOBER 1978

Animal Number	Muscle K (g/kg*) ^{137}Cs (pCi/kg*)	Lungs K (g/kg*)	Liver K (g/kg*) ^{137}Cs (pCi/kg*)	Kidney K (g/kg*) ^{137}Cs (pCi/kg*)	Thyroid ^{131}I (pCi/g)	Blood ^{3}H (pCi/l)
7	3.9 ± 0.3 22 ± 14	5.7 ± 0.47	3.3 ± 0.23 <MDA	2.4 ± 0.3 250 ± 120	Gamma Spectrum Negligible	<420
8	3.8 ± 0.29 <MDA	4.8 ± 0.49	4.8 ± 0.41 <MDA	7.1 ± 0.64 <MDA	Gamma Spectrum Negligible	<420
9	3.2 ± 0.28 16 ± 13	4.6 ± 0.35	4.9 ± 0.3 14 ± 10	7.3 ± 0.65 <MDA	Gamma Spectrum Negligible	<420
10	3.8 ± 0.25 19 ± 10	5.5 ± 0.48	8.7 ± 0.71 <MDA	6.7 ± 0.53 <MDA	Sample not collected	<420
11	4.2 ± 0.31 39 ± 13	Sample lost	3.2 ± 0.23 <MDA	3.8 ± 0.28 22 ± 14	Sample not collected	<420
12	4.7 ± 0.31 71 ± 13	11 ± 1.0	13 ± 0.79 <MDA	9.0 ± 7.4 55 ± 48	Sample not collected	<420
Median	3.9 21	5.5	4.9 <MDA	6.9 <MDA		<420
Range	3.2-4.7 <MDA-71	4.6-11	3.2-13 <MDA-14	2.4-9.0 <MDA-250		<420- <420

*Wet weight

TABLE D-1. PLUTONIUM CONCENTRATIONS IN SELECTED TISSUES, MULE DEER, NTS, 1978

Animal Number	Lungs			Muscles			Liver			Rumen Contents		
	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)
1	<0.02 <1.1	<0.02 <1.2	5.8	0.02 ± 0.01 1.2 ± 0.61	<0.02 <1.2	6.1	<0.02 <1.2	<0.02 <1.2	6.2	<0.02 <0.63	0.08 ± 0.03 2.5 ± 0.95	3.2
2	<0.027 <0.85	0.071 ± 0.037 2.2 ± 1.2	3.1	<0.02 <0.6	0.02 ± 0.01 0.06 ± 0.3	3.0	<0.02 <0.69	<0.02 <0.69	3.5	Sample not collected		
3	<0.02 <0.76	<0.02 <0.76	3.8	<0.02 <1.1	<0.021 <1.1	5.3	<0.02 <1.4	<0.02 <1.4	6.7	<0.01 <0.67	0.01 ± 0.01 0.67 ± 0.67	6.7
4	<0.002 <0.12	0.006 ± 0.003 0.36 ± 0.18	6.0	<0.008 <0.43	<0.007 <0.38	5.4	<0.008 <0.31	0.039 ± 0.012 1.5 ± 0.46	3.9	<0.01 <0.70	<0.01 <0.70	19.5
5	<0.005 <0.3	0.043 ± 0.009 2.6 ± 0.55	6.1	<0.002 <0.086	0.017 ± 0.005 0.73 ± 0.22	4.3	0.37 ± 0.08 4.1 ± 0.89	0.16 ± 0.047 1.8 ± 0.52	1.1	<0.006 <0.31	0.013 ± 0.007 0.68 ± 0.37	5.2
6	<0.002 <0.14	0.005 ± 0.003 0.35 ± 0.21	7.0	<0.013 <0.63	0.059 ± 0.023 2.9 ± 1.1	4.9	<0.036 <0.20	0.08 ± 0.039 0.44 ± 0.21	0.6	0.02 ± 0.008 0.39 ± 0.16	0.057 ± 0.015 1.1 ± 0.29	2.0
Median	<0.013 <0.53	<0.02 <0.98	5.9	<0.02 <0.62	<0.02 <1.1	5.1	<0.02 <0.95	<0.03 <1.3	3.7	<0.01 <0.67	0.013 <0.7	5.2
Range	<0.002-<0.027 0.12-<1.1	<0.005-0.071 0.35-2.6	3.1-7.0	0.002-0.02 <0.086-1.2	<0.007-0.059 <0.38-2.9	3.0-6.1	<0.008-0.37 <0.20-4.1	<0.02-0.16 0.44-1.8	0.6-6.7	<0.006-0.02 <0.31-<.70	<0.01-0.08 0.67-2.5	2.0-19.5

*Wet weight

TABLE D-2. PLUTONIUM CONCENTRATIONS IN GONADS, MULE DEER, NTS, 1978

Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)
4	<0.02 <0.19	<0.02 <0.19	0.93
6	<0.01 .0.80	<0.01 <0.80	8.0

*Wet weight

TABLE D-3. PLUTONIUM AND STRONTIUM CONCENTRATIONS IN BONES (HOCK), MULE DEER, NTS, 1978

Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	^{89}Sr (pCi/g Ash) (pCi/kg*)	^{90}Sr (pCi/g Ash) (pCi/kg*)	Ash (%)
1	<0.02 <6.5	<0.02 <6.5	<2.1 <670	2.6 ± 0.62 850 ± 200	32
2	<0.02 <2.6	<0.02 <2.6	<2.9 <380	2.3 ± 0.64 300 ± 84	13
3	<0.02 <5.1	<0.02 <5.1	<2.7 <710	1.8 ± 0.62 470 ± 160	26
**4	<0.004 <1.4	<0.004 <1.4	<97 <35,000	1.8 ± 160 660 ± 93	36
**5	<0.004 <1.4	<0.004 <1.4	<18 <5,400	3.8 ± 0.17 1,300 ± 60	35
**6	<0.003 <0.9	<0.003 <0.9	<41 <12,000	3.4 ± 0.30 1,000 ± 90	30
Median	<0.012 <2.0	<0.012 <2.0	<11 <3,600	2.5 760	31
Range	<0.003-<0.02 <0.9-<5.1	<0.003-<0.02 <0.9-<5.1	<2.1-<97 <380-<35,000	1.8-3.8 300-1,300	13-36

*Wet weight
**Strontium Analyses by Eberline Instrument Corporation.

TABLE D-4. GAMMA-EMITTING RADIONUCLIDES AND TRITIUM CONCENTRATIONS IN SELECTED TISSUES, MULE DEER, NTS, 1978

Animal Number	Muscle	Lungs	Liver	Kidney	Rumen Contents	Thyroid	Blood
	K (g/kg*) ^{137}Cs (pCi/kg*)	K (g/kg*)	K (g/kg*) ^{137}Cs (pCi/kg*)	K (g/kg*) ^{137}Cs (pCi/kg*) ^{3}H (pCi/l†)	K (g/kg*) ^{137}Cs (pCikg*) ^{95}Zr (pCi/kg*) ^{144}Ce (pCi/kg*)	^{131}I (pCi/g)	^{3}H (pCi/l)
1	8.7 ± 0.56 50 ± 29	2.8 ± 0.4	1.9 ± 0.3 <MDA	2.5 ± 0.2 39 ± 12 <390	7.8 ± 0.61 54 ± 30 <MDA <MDA	7.5 ± 2.3	450 ± 240
2	6.7 ± 0.53 <MDA	2.1 ± 0.24	11 ± 1 <MDA	27 ± 2.7 <MDA <390	Sample not collected	Sample not collected	Sample not collected
3	7.6 ± 0.59 74 ± 29	2.0 ± 0.34	2.9 ± 0.23 31 ± 13	14 ± 1.2 <MDA <390	4.5 ± 0.39 68 ± 20 85 ± 19 360 ± 76	Sample not collected	Sample not collected
4	7.6 ± 0.14 16 ± 4.9	6.6 ± 0.55	2.2 ± 0.66 11 ± 4.5	3.3 ± 0.26 41 ± 15 <310	1.5 ± 0.23 33 ± 15 <MDA 190 ± 81	Sample not collected	Sample not collected
5	7.8 ± 0.4 24 ± 15	15 ± 1.1	1.6 ± 0.16 <MDA	9.7 ± 0.8 <MDA 77,000 ± 720	3.3 ± 0.27 44 ± 17 <MDA <MDA	Sample not collected	Sample not collected
6	10 ± 0.69 <MDA	3.3 ± 0.44	3.5 ± 0.3 <MDA	8.1 ± 0.57 31 ± 27 <310	5.6 ± 1.4 <MDA <MDA <MDA 8,400 ± 3,100‡	Sample not collected	Sample not collected
Median	7.7 20	3.1	2.6 <MDA	8.9 <31 <390	4.5 44 <MDA		
Range	6.7-10 <MDA-74	2-15	1.6-11 <MDA-31	2.5-27 <MDA-41 <310-77,000	1.5-7.8 <MDA-68 <MDA-85 <MDA-360		

*Wet weight
†Aqueous portion of kidney
<MDA = Less than minimum detectable activity
‡^{7}Be (pCi/kg wet weight)

TABLE E-1. PLUTONIUM AND STRONTIUM CONCENTRATIONS IN BONES, DESERT BIGHORN SHEEP, 1978+

Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	^{89}Sr (pCi/g Ash) (pCi/kg*)	^{90}Sr (pCi/g Ash) (pCi/kg*)	Ash (%)
1	<0.005 <1.4	0.046 ± 0.012 13 ± 3.4	<7.4 <2,100	5.4 ± 0.26 1,500 ± 70	28
2	0.012 ± 0.008 3.6 ± 2.4	0.023 ± 0.011 6.8 ± 3.3	<9.6 <2,900	4.4 ± 0.28 1,300 ± 70	30
3	<0.003 <1.4	0.006 ± 0.005 2.7 ± 2.3	<11 <5,000	5.5 ± 0.25 2,500 ± 110	46
4	<0.003 <0.83	<0.003 <0.83	<14 <4,000	4.5 ± 0.19 1,200 ± 50	28
5	<0.005 <2.1	<0.005 <2.1	<19 <7,700	6.8 ± 0.24 2,800 ± 100	41
6	<0.003 <1.0	<0.004 <1.3	<7.3 <2,400	2.3 ± 0.16 780 ± 54	34
7	<0.007 <2.9	<0.007 <2.9	<9.4 <3,900	3.2 ± 0.18 1,300 ± 70	42
8	0.007 ± 0.006 2.1 ± 1.8	0.012 ± 0.008 3.6 ± 2.4	<19 <5,700	7.1 ± 0.20 2,200 ± 60	30
9	<0.005 <2.1	<0.004 <1.7	<12 <5,000	3.9 ± 0.17 1,600 ± 70	42
10	<0.006 <2.4	<0.006 <2.4	<16 <6,400	5.3 ± 0.18 2,100 ± 70	41
11	<0.003 <1.1	<0.003 <1.1	<19 <7,100	5.9 ± 0.18 2,200 ± 70	38
12	<0.003 <1.1	<0.006 <2.2	<13 <4,800	3.2 ± 0.15 1,200 ± 60	37
13	<0.006 <2.6	<0.006 <2.6	<11 <4,500	3.3 ± 0.14 1,400 ± 60	43
Median	<0.005 <2.1	<0.006 <2.4	<12 <4,800	4.5 1,500	38
Range	<0.003-0.012 <0.83-3.6	<0.003-0.046 <0.83-13	<7.3 - <19 <1,200 - <7,700	2.3 - 7.1 780 - 2,800	28-46

+All analyses by Eberline Instrument Corporation.
*Wet weight

TABLE F-1. PLUTONIUM CONCENTRATIONS IN SELECTED TISSUES, RABBITS, AREA 18, NTS, 1978

Animal Number	Muscle			Internal Organs			G. I. Tract		
	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)
1	<0.012 <0.49	<0.016 <0.65	4.0	<0.004 <0.26	0.011 ± 0.006 0.71 ± 0.39	6.4	<0.01 <0.78	0.01 ± 0.01 0.78 ± 0.78	7.8
2	<0.017 <0.62	<0.012 <0.44	3.6	<0.009 <0.55	<0.008 <0.49	6.1	<0.01 <0.56	<0.01 <0.56	5.6
3	<0.005 <0.31	0.014 ± 0.009 0.87 ± 0.56	6.2	<0.004 <0.22	0.05 ± 0.01 2.7 ± 0.55	5.5	0.042 ± 0.013 1.8 ± 0.52	0.4 ± 0.05 16 ± 2.0	4.0
4	<0.01 <0.51	<0.01 <0.51	5.1	0.01 ± 0.01 0.46 ± 0.46	0.09 ± 0.03 4.1 ± 1.4	4.6	<0.01 <0.58	0.03 ± 0.02 1.7 ± 1.2	5.8
5	0.029 ± 0.007 2.3 ± 0.56	0.16 ± 0.02 13 ± 1.6	8.1	3.8 ± 0.54 370 ± 46	23.7 ± 3.2 2,000 ± 270	8.5	<0.012 <0.72	0.07 ± 0.03 4.3 ± 1.9	6.0
6	<0.01 <0.65	0.01 ± 0.01 0.65 ± 0.65	6.5	<0.01 <0.55	0.01 ± 0.01 0.55 ± 0.55	5.5	<0.01 <1.2	0.01 ± 0.01 1.2 ± 1.2	11
Median	<0.011 <0.57	0.012 0.76	5.7	<0.01 <0.55	0.031 1.7	5.8	<0.01 <0.75	0.02 1.5	5.9
Range	<0.005-0.029 <0.31-2.3	<0.01-0.16 <0.51-13	3.6-8.1	<0.004-3.8 <0.22-370	<0.009-23.7 <0.49-2,000	4.6-8.5	<0.01-0.04 <0.56-1.8	<0.01-0.4 <0.56-16	4-11

*Wet weight

TABLE F-2. PLUTONIUM AND STRONTIUM CONCENTRATIONS IN BONE AND SKIN, RABBITS, AREA 18, NTS, 1978

	Bone					Skin		
Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	^{89}Sr (pCi/g Ash) (pCi/kg*)	^{90}Sr (pCi/g Ash) (pCi/kg*)	Ash (%)	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)
1	<0.01 <2.0	<0.01 <2.0	<6.5 <1,300	1.5 ± 0.55 310 ± 110	20	0.01 ± 0.01 1.1 ± 1.1	0.05 ± 0.02 5.4 ± 2.0	11
2	<0.01 <2.2	<0.01 <2.2	<6.4 <1,400	0.77 ± 0.4 170 ± 89	22	<0.02 <1.2	<0.02 <1.2	5.8
3	<0.01 <2.0	<0.01 <2.0	<0.55 <110	2.3 ± 0.95 460 ± 190	20	0.05 ± 0.04 6.3 ± 5.0	1.2 ± 0.3 150 ± 38	12
4	0.01 ± 0.01 2.0 ± 2.0	0.01 ± 0.01 2.0 ± 2.0	<6.5 <1,300	3.9 ± 0.85 780 ± 170	20	0.03 ± 0.01 2.2 ± 0.73	0.07 ± 0.02 5.1 ± 1.5	7.3
5	<0.01 <2.1	<0.01 <2.1	<6.5 <1,300	0.85 ± 0.48 170 ± 97	20	<0.01 <1.1	0.03 ± 0.02 3.3 ± 2.2	11
6	<0.01 <2.1	<0.01 <2.1	<6.5 <1,400	0.7 ± 0.42 150 ± 89	21	0.01 ± 0.01 0.91 ± 0.91	0.01 ± 0.01 0.91 ± 0.91	9.1
Median	<0.01 <2.1	<0.01 <2.1	<6.5 <1,300	1.2 240	20	<0.02 <1.2	0.04 4.2	10.1
Range	<0.01-0.01 <2.0-<2.2	<0.01-0.01 <2.0-<2.2	<0.55-<6.5 <110-<1,400	0.7-3.9 150-780	20-22	<0.01-0.05 0.91-6.3	0.01-1.2 0.91-150	5.8-12

*Wet weight

TABLE F-3. GAMMA-EMMITTING RADIONUCLIDES AND TRITIUM CONCENTRATIONS IN SELECTED TISSUES, RABBITS, AREA 18, NTS, 1978

Animal Number	Muscle	Internal Organs	G. I. Tract	Skin
	K (g/kg*)		K (g/kg*)	
	^{137}Cs (pCi/kg*)		^{137}Cs (pCi/kg*)	
	^{3}H (pCi/l†)	K (g/kg*)	^{7}Be (pCi/kg*)	K (g/kg*)
		^{137}Cs (pCi/kg*)	^{95}Zr (pCi/kg*)	^{137}Cs (pCi/kg*)
			^{144}Ce (pCi/kg*)	^{144}Ce (pCi/kg*)
1	5.9 ± 0.4	2.8 ± 0.39	8.0 ± 0.63	22 ± 3.1
	99 ± 25	<MDA	110 ± 31	870 ± 160
	530 ± 250		4,100 ± 2,000	2,200 ± 970
			<MDA	
			210 ± 18	
2	9.2 ± 0.51	13 ± 11	4.9 ± 0.25	<MDA
	150 ± 20	<MDA	60 ± 18	130 ± 85
	540 ± 250		2,200 ± 1,200	<MDA
			<MDA	
			<MDA	
3	4.6 ± 0.26	7.7 ± 0.58	4.7 ± 0.41	<MDA
	41 ± 12	<MDA	94 ± 25	100 ± 90
	500 ± 250		4,200 ± 660	<MDA
			<MDA	
			<MDA	
4	4.0 ± 0.27	5.7 ± 0.91	5.2 ± 0.54	5.7 ± 2.3
	48 ± 15	140 ± 45	76 ± 28	<MDA
	<390		<MDA	<MDA
			160 ± 95	
			290 ± 140	
5	12 ± 1.0	2.0 ± 0.19	5.8 ± 0.39	Gamma
	84 ± 65	15 ± 9.0	46 ± 20	Spectrum
	<400		<MDA	Negligible
			<MDA	
			<MDA	
6	8.5 ± 0.6	6.8 ± 0.75	8.8 ± 0.55	4.2 ± 1.7
	46 ± 33	<MDA	84 ± 26	<MDA
	<390		<MDA	<MDA
			<MDA	
			<MDA	
Median	7.2	6.3	5.5	4.2
	66	<MDA	80	<MDA
	<450		2,200	<MDA
			<MDA	
			<MDA	
Range	4-12	2-13	4.7-8.8	<MDA-22
	41-150	<MDA-140	46-110	<MDA-870
	<390-540		<MDA-4,200	<MDA-2,200
			<MDA-160	
			<MDA-290	

*Wet weight †Aqueous portion of muscle <MDA = Less than minimum detectable activity

TABLE G-1. PLUTONIUM CONCENTRATIONS IN SELECTED TISSUES, RABBITS, AREA 15, NTS, 1978

Animal Number	G. I. Tract			Internal Organs			Muscle			Skin		
	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	Ash (%)
1	0.08 ± 0.03 3.9 ± 1.5	0.52 ± 0.11 25 ± 5.4	4.9	0.06 ± 0.03 2.8 ± 1.4	0.04 ± 0.02 1.9 ± 0.94	4.7	<0.02 <1.0	<0.02 <1.0	5.1	0.05 ± 0.03 5.3 ± 3.2	0.06 ± 0.03 6.4 ± 3.2	6.3
2	0.20 ± 0.07 8.7 ± 1.8	14 ± 5.0 623 ± 129	7.2	<0.01 <0.49	0.08 ± 0.04 3.9 ± 10	4.9	<0.02 <0.49	<0.02 <0.49	2.5	0.06 ± 0.03 0.21 ± 0.05	4.2 ± 2.1 15 ± 3.5	8.8
3	0.07 ± 0.02 3.8 ± 1.1	1.0 ± 0.11 56 ± 6.0	5.4	0.02 ± 0.01 0.83 ± 0.41	0.09 ± 0.02 3.7 ± 0.82	4.1	<0.02 <1.8	<0.02 <1.8	9.1	0.021 ± 0.004 1.3 ± 0.63	0.16 ± 0.03 10 ± 1.9	8.1
4	0.08 ± 0.03 4.4 ± 1.65	2.7 ± 0.4 150 ± 22	5.5	<0.01 <0.43	0.10 ± 0.07 4.3 ± 3.0	4.3	0.02 ± 0.01 0.99 ± 0.49	0.03 ± 0.01 1.5 ± 0.49	4.9	0.02 ± 0.01 1.8 ± 0.88	0.30 ± 0.06 27 ± 5.3	7.0
5	0.03 ± 0.01 1.8 ± 0.61	0.49 ± 0.06 30 ± 3.7	6.2	0.01 ± 0.01 0.47 ± 0.47	0.07 ± 0.02 3.3 ± 0.95	4.7	<0.007 <0.55	0.061 ± 0.027 4.8 ± 2.1	7.8	0.02 ± 0.01 1.6 ± 0.81	0.10 ± 0.03 8.1 ± 2.4	11
6	1.0 ± 0.12 37 ± 4.4	0.3 ± 0.49 11 ± 1.8	3.7	0.03 ± 0.01 2.1 ± 0.71	0.02 ± 0.01 1.4 ± 0.71	7.1	<0.01 <0.56	<0.01 <0.56	5.6	<0.02 <1.4	0.04 ± 0.03 2.8 ± 2.1	6.9
7	0.49 ± 0.001 3.5 ± 0.71	0.64 ± 0.071 45 ± 5.0	7.1	0.02 ± 0.01 1.1 ± 0.55	0.30 ± 0.05 16 ± 2.7	5.5	0.01 ± 0.01 0.51 ± 0.51	0.01 ± 0.01 0.51 ± 0.51	5.1	0.10 ± 0.029 14 ± 3.8	4.8 ± 0.67 620 ± 85	13
8	0.039 ± 0.02 1.4 ± 0.72	1.8 ± 0.22 65 ± 7.9	3.6	0.50 ± 0.10 32 ± 6.4	1.2 ± 0.2 76 ± 13	6.4	<0.01 <0.62	0.03 ± 0.01 1.9 ± 0.62	6.2	0.02 ± 0.01 2.0 ± 1.0	0.31 ± 0.08 31 ± 8.1	4.6
9	0.051 ± 0.014 7.4 ± 2.0	2.7 ± 0.37 390 ± 53	14	<0.007 <0.48	0.11 ± 0.021 7.5 ± 1.5	6.9	0.2 ± 0.038 11 ± 2.2	1.1 ± 0.15 66 ± 8.61	5.8	0.26 ± 0.041 12.2 ± 2.0	4.9 ± 0.95 240 ± 22	4.8
10	0.043 ± 0.012 2.1 ± 0.59	0.43 ± 0.061 21 ± 3.0	4.9	<0.004 <0.25	0.032 ± 0.011 2.0 ± 0.69	6.3	0.066 ± 0.029 0.51 ± 0.22	0.051 ± 0.025 0.39 ± 0.19	0.8	0.084 ± 0.02 5.8 ± 1.4	2.0 ± 0.21 140 ± 15	6.9
11	0.041 ± 0.012 1.7 ± 0.5	1.2 ± 0.12 48 ± 5.0	4.1	<0.009 <0.51	0.062 ± 0.017 3.5 ± 0.96	5.7	0.016 ± 0.009 0.22 ± 0.13	0.028 ± 0.012 0.39 ± 0.17	1.4	<0.009 <0.27	<0.007 <0.21	3.0
12	0.026 ± 0.010 1.3 ± 0.49	1.1 ± 0.12 52 ± 5.9	4.9	0.018 ± 0.013 1.7 ± 1.0	0.046 ± 0.021 3.2 ± 1.5	6.9	<0.023 <0.94	0.042 ± 0.021 1.7 ± 0.86	4.1	<0.023 <0.79	0.1 ± 0.047 3.5 ± 1.6	3.4
13	0.025 ± 0.012 1.8 ± 0.85	1.1 ± 0.18 81 ± 13	7.1	0.013 ± 0.01 0.65 ± 0.5	0.25 ± 0.057 12 ± 2.6	5.0	<0.008 <0.48	0.015 ± 0.007 0.90 ± 0.42	6.0	0.16 ± 0.024 23 ± 3.4	5.8 ± 0.5 820 ± 71	14
Median	0.051 3.5	1.1 52	5.4	0.013 0.65	0.08 3.7	5.5	<0.02 <0.56	0.028 <1.0	5.1	<0.023 1.6	0.3 10	6.9
Range	0.025 - 1.0 1.3 - 37	0.3-14 11-623	3.6-14	<0.004-0.06 <0.25-32	0.02-1.2 1.4-76	4.1-7.1	<0.007-0.2 <0.22-11	<0.01-1.1 0.39-66	0.8-9.1	<0.009-0.26 <0.021-14	<0.007-5.8 <0.21-820	3-14

*Wet weight

TABLE G-2. PLUTONIUM AND STRONTIUM CONCENTRATIONS IN BONES, RABBITS, AREA 15, NTS, 1978

Animal Number	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	^{89}Sr (pCi/g Ash) (pCi/kg*)	^{90}Sr (pCi/g Ash) (pCi/kg*)	Ash (%)
1	0.01 ± 0.01 0.86 ± 0.86	4.0 ± 0.02 3.4 ± 1.7	<31 <2,400	2.7 ± 0.67 210 ± 51	7.8
2	<0.01 <3.0	<0.01 <3.0	<57 <17,000	5.3 ± 0.9 1,600 ± 270	30
3	<0.01 <0.89	0.01 ± 0.01 0.89 ± 0.89	<60 <4,800	5.4 ± 0.98 430 ± 78	8
4	<0.01 <1.0	<0.01 <1.0	<12 <1,200	2.8 ± 0.82 280 ± 82	10
5	<0.01 <0.89	0.03 ± 0.01 2.7 ± 0.89	<11 <910	4.3 ± 0.95 340 ± 76	8
6	<0.01 <0.91	<0.01 <0.91	3.9 ± 1.5 330 ± 130	2.0 ± 0.7 170 ± 59	8.4
7	<0.01 <1.5	<0.01 <1.5	<14 <2,100	3.2 ± 0.92 490 ± 140	15
8	<0.01 <0.93	<0.011 <0.93	<31 <2,600	4.7 ± 0.83 400 ± 71	8.6
9**	<0.003 <0.55	0.01 ± 0.007 1.8 ± 1.3	<60 <11,000	4.8 ± 0.49 880 ± 90	18
10**	<0.006 <1.1	<0.006 <1.1	<84 <15,000	13 ± 0.7 2,300 ± 120	17
11**	<0.004 <0.8	<0.006 <1.2	<52 <1,000	7.9 ± 0.43 1,600 ± 90	20
12**	<0.009 <0.84	0.025 ± 0.018 2.3 ± 1.7	<140 <13,000	6.7 ± 1.1 620 ± 100	9.3
13**	<0.005 <0.77	0.025 ± 0.018 3.8 ± 2.8	<120 <18,000	7 ± 0.97 1,100 ± 150	15
Median	<0.01 <0.89	<0.01 <1.5	<52 <4,800	4.8 490	10
Range	<0.003-0.01 <0.55-<3.0	<0.006-0.04 <0.89-3.8	3.9 - <140 330 - <18,000	2.0 - 13 170 - 2,300	7.8-30

*Wet weight
**Strontium analyses by Eberline Instrument Corporation.

TABLE G-3. GAMMA-EMMITTING RADIONUCLIDE AND TRITIUM CONCENTRATIONS IN SELECTED TISSUES, RABBITS, AREA 15, NTS, 1978

Animal Number	Muscle K (g/kg*) ^{137}Cs (pCi/kg*) ^{3}H (pCi/l†)	Internal Organs K (g/kg*) ^{137}Cs (pCi/kg*)	G. I. Tract K (g/kg*) ^{137}Cs (pCi/kg*) ^{95}Zr (pCi/kg*) ^{144}Ce (pCi/kg*)	Skin K (g/kg*) ^{137}Cs (pCi/kg*)
1	9.9 ± 0.68 110 ± 16 12,000 ± 520	5.3 ± 1.3 <MDA	4.3 ± 0.93 280 ± 69 <MDA <MDA	Gamma Spectrum Negligible
2	8.6 ± 0.66 94 ± 42 13,000 ± 540	4.1 ± 0.21 91 ± 23	12 ± 0.87 200 ± 53 <MDA 890 ± 480	31 ± 2.5 <MDA
3	4.5 ± 0.17 130 ± 17 14,000 ± 550	3.9 ± 1.5 <MDA	9.1 ± 1.4 250 ± 71 <MDA <MDA	Gamma Spectrum Negligible
4	11 ± 0.94 120 ± 43 6,400 ± 460	8.1 ± 2.3 <MDA	5.5 ± 0.53 230 ± 39 370 ± 160 <MDA	4.6 ± 1.0 <MDA
5	11 ± 0.83 130 ± 54 3,300 ± 420	18 ± 1.4 190 ± 75	5.9 ± 0.63 280 ± 36 <MDA <MDA	2.2 ± 1.7 <MDA
6	3.8 ± 0.27 79 ± 15 13,000 ± 540	4.6 ± 0.84 84 ± 47	5.8 ± 1.2 120 ± 55 <MDA <MDA	Gamma Spectrum Negligible
7	8.6 ± 0.17 160 ± 4.3 11,000 ± 510	3.7 ± 0.26 110 ± 18	5.1 ± 0.47 150 ± 24 300 ± 90 510 ± 110	2.7 ± 2.1 <MDA

(continued)

*Wet weight
†Aqueous portion of muscle
<MDA = Less than minimum detectable activity

TABLE G-3. (Continued)

Animal Number	Muscle K (g/kg*) ^{137}Cs (pCi/kg*) ^{3}H (pCi/l+)	Internal Organs K (g/kg*) ^{137}Cs (pCi/kg*)	G. I. Tract K (g/kg*) ^{137}Cs (pCi/kg*) ^{95}Zr (pCi/kg*) ^{144}Ce (pCi/kg*)	Skin K (g/kg* ^{137}Cs (pCi/kg*
8	11 ± 0.84 <MDA 7,200 ± 470	5.7 ± 1.2 100 ± 65	6.8 ± 1.2 110 ± 55 <MDA <MDA	2.4 ± 1.5 <MDA
9	5.8 ± 0.36 71 ± 14 4,800 ± 320	3.9 ± 0.49 59 ± 24	6.9 ± 0.66 280 ± 42 <MDA <MDA	4.4 ± 3.4 57 ± 35
10	11 ± 0.71 130 ± 42 3,300 ± 300	5.9 ± 0.53 100 ± 28	3.3 ± 0.33 140 ± 22 <MDA <MDA	2.6 ± 1.3 110 ± 74
11	6.7 ± 0.34 67 ± 14 2,300 ± 280	4 ± 0.55 150 ± 35	Sample lost	Sample los
12	17 ± 1.4 <MDA 4,100 ± 310	5.2 ± 2.9 550 ± 190	4.4 ± 0.51 170 ± 33 <MDA <MDA	5.7 ± 2.0 220 ± 95
13	6.5 ± 1.4 100 ± 18 2,400 ± 280	Sample lost	5.3 ± 1.1 150 ± 62 <MDA <MDA	4.9 ± 2.1 710 ± 110
Median	8.6 100 6,400	4.9 95	5.7 <MDA 165 <MDA	2.7 <MDA
Range	3.8-17 <MDA-160 2,300-14,000	3.7-18 <MDA-550	4.3-9.1 110-280 <MDA-370 <MDA-890	<MDA-31 <MDA-710

*Wet weight
+Aqueous portion of muscle
<MDA = Less than minimum detectable activity

TABLE H-1. PLUTONIUM+, STRONTIUM+, TRITIUM, AND GAMMA-EMITTING RADIONUCLIDES CONCENTRATIONS IN SELECTED TISSUES, CHUKAR, NTS, 1978

Animal Number and Tissue Type	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	^{89}Sr (pCi/g Ash) (pCi/kg*)	^{90}Sr (pCi/g Ash) (pCi/kg*)	Ash (%)	K (g/kg*) ^{137}Cs (pCi/kg*)	^{3}H++ (pCi/l)
Chukar-1 Muscle	<0.01 <0.41	<0.005 <0.2	NA	NA	4.1	5.2 ± 0.38 41 ± 18	1,500 ± 370
Chukar-2 Muscle	<0.006 <0.5	<0.006 <0.67	NA	NA	8.4	10 ± 0.83 <MDA	700 ± 300
Chukar-1 G.I. tract	0.014 ± 0.012 1.3 ± 1.1	0.21 ± 0.055 20 ± 5.2	NA	NA	9.4	5.6 ± 1.7 <MDA	NA
Chukar-2 G.I. tract	<0.015 <1.1	0.057 ± 0.078 4.1 ± 2	NA	NA	7.1	9.9 ± 3.5 <MDA	NA
Chukar-1 Internal organs	0.008 ± 0.005 1.4 ± 0.86	0.034 ± 0.011 5.8 ± 1.9	NA	NA	17	8.9 ± 1.5 <MDA	NA
Chukar-2 Internal organs	<0.003 <0.38	<0.011 <1.4	NA	NA	12	18 ± 13 <MDA	NA
Chukar-1 Bone	<0.006 <0.75	0.027 ± 0.015 3.4 ± 1.9	<21 <2,600	6.3 ± 0.75 780 ± 94	12.5	NA	NA
Chukar-2 Bone	<0.01 <1.2	0.11 ± 0.065 13 ± 8.1	<32 <3,900	13.0 ± 1.0 1,600 ± 120	12	NA	NA

*Wet weight
+Plutonium and Strontium analyses by Eberline Instrument Corporation.
++From aqueous portion of muscle.
NA = Not analyzed
G.I. = Gastrointestinal tract
<MDA = less than minimum detectable activity

TABLE I-1. PLUTONIUM+, STRONTIUM+, TRITIUM, AND GAMMA-EMITTING RADIONUCLIDES CONCENTRATIONS IN SELECTED TISSUES, EAGLES, NTS, 1978

Animal Number and Tissue Type	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	^{89}Sr (pCi/g Ash) (pCi/kg*)	^{90}Sr (pCi/g Ash) (pCi/kg*)	Ash (%)	K (g/kg*) ^{137}Cs (pCi/kg*)	^{3}H (pCi/l)++
Eagle-1	0.037 ± 0.016	0.24 ± 0.048	NA	NA	2.1	5.7 ± 3.2	4,700 ± 320
Muscle	0.76 ± 0.33	4.9 ± 0.99				28 ± 11	
Eagle-2	<0.014	0.011 ± 0.01	NA	NA	2.3	NA	47,000 ± 813
Muscle	<0.32	0.25 ± 0.23					
Eagle-3	<0.008	0.017 ± 0.011	NA	NA	1.8	5.5 ± 3.3	760 ± 290
Muscle	<0.15	0.31 ± 0.20				57 ± 14	
Eagle-1	<0.017	<0.045	NA	NA	7.6	5.8 ± 0.58	NA
Stomach contents	<1.3	<3.4				35 ± 28	
Eagle-2	<0.018	0.036 ± 0.030	NA	NA	2.5	4.9 ± 1.1	NA
Stomach contents	<0.44	0.86 ± 0.74				<MDA	
Eagle-3	<0.004	<0.013	NA	NA	6.9	5.4 ± 1.8	NA
Stomach contents	<0.28	<0.9				<MDA	
Eagle-1	<0.01	0.035 ± 0.016	NA	NA	3.5	11 ± 0.97	NA
Internal organs	<0.55	1.2 ± 0.56				<MDA	
Eagle-2	<0.005	<0.005	NA	NA	3.9	2.7 ± 0.52	NA
Internal organs	<0.19	<0.19				<MDA	
Eagle-3	<0.003	0.016 ± 0.009	NA	NA	7.3	6.7 ± 0.52	NA
Internal organs	<0.22	1.2 ± 0.66				<MDA	
Eagle-1	<0.003	<0.005	<60	1.9 ± 0.16	20	NA	NA
Bone	<0.6	<1.0	<12,000	370 ± 32			
Eagle-2	<0.005	0.007 ± 0.006	<27	5.4 ± 0.12	19	NA	NA
Bone	<0.93	1.3 ± 1.1	< 5,000	1,000 ± 20			
Eagle-3	<0.006	<0.006	<9.6	2.3 ± 0.13	25	NA	NA
Bone	<1.5	<1.5	< 2,400	580 ± 57			

*Wet weight
+Plutonium and Strontium analyses by Eberline Instrument Corporation.
++From aqueous portion of muscle.
NA = Not analyzed
<MDA = less than minimum detectable activity

TABLE J-1. PLUTONIUM+, STRONTIUM+, TRITIUM, AND GAMMA-EMITTING RADIONUCLIDES CONCENTRATIONS IN SELECTED TISSUES, HORSE, NTS, 1978

Animal Number and Tissue Type	^{238}Pu (pCi/g Ash) (pCi/kg*)	^{239}Pu (pCi/g Ash) (pCi/kg*)	^{89}Sr (pCi/g Ash) (pCi/kg*)	^{90}Sr (pCi/g Ash) (pCi/kg*)	Ash (%)	K (g/kg*) ^{137}Cs (pCi/kg*)	^{3}H (pCi/l)
Horse Muscle	0.01 ± 0.01 0.54 ± 0.54	<0.01 <0.54	NA	NA	5.4	6.0 ± 0.35 51 ± 15	NA
Horse Liver	0.01 ± 0.01 0.67 ± 0.67	0.67 ± 0.67 2.0 ± 0.67	NA	NA	6.6	7.9 ± 0.72 <MDA	NA
Horse Lung	0.01 ± 0.01 0.46 ± 0.46	0.02 ± 0.01 0.92 ± 0.46	NA	NA	4.6	14 ± 1.15 <MDA	NA
Horse Gonads	<0.03 <1.1	<0.03 <1.1	NA	NA	3.6	NA	NA
Horse Bone	<0.003 <0.88	0.007 ± 0.006 2.1 ± 1.8	<36 <11,000 2,800	9.4 ± 0.25 ± 70	29	NA	NA
Horse Kidney	NA	NA	NA	NA	NA	7.2 ± 0.57 <MDA	670 ± 260

*Wet weight
NA = Not analyzed
<MDA = less than minimum detectable activity
+Plutonium and Strontium analysis by Eberline Instrument Corporation.

APPENDIX K. GROSS* AND MICROSCOPIC PATHOLOGY† FOUND IN NECROPSIED ANIMALS, 1978

AREA 18 CATTLE, MAY

1

Necropsy findings: Rumen contents scanty, lungs were emphysematous and wet appearing.

Histopathological findings: Mild congestion of lungs, small focal aggregates of lymphocytes located in the interstitium of the cortex of the kidney, and mild hemosiderosis of the lungs.

Hematological findings: Blood samples not collected as tubes and slides not available.

Clinical diagnosis: Normal, 12-year-old, lactating cow that died from respiratory failure following spraying with Dichlorvos (Vapona®).

2

Necropsy findings: Lungs were emphysematous.

Histopathological findings: Localized hemorrhage in lungs, congestion of glomeruli and interstitial areas of kidney, and mild congestion of the adrenal cortical sinusoids.

Hematological findings: Blood samples not collected as tubes and slides not available.

Clinical diagnosis. Normal, 3-year-old steer that died from respiratory failure following spraying with Dichlorvos (Vapona®).

3

Necropsy findings: Lungs were emphysematous.

Histopathological findings: Kidney congestion and moderate congestion of the adrenal cortical sinusoids.

---

*As reported by senior author
†As reported by Dr. Billy C. Ward, College of Veterinary Medicine, drawer V. Mississippi State University, Starkville, Mississippi.
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3 (Continued)

Hematological findings: Blood samples not collected as tubes and slides not available.

Clinical diagnosis: Normal, 3-year-old steer that died from respiratory failure following spraying with Dichlorvos (Vapona®).

4

Necropsy findings: Lungs were emphysematous.

Histopathological findings: Sarcocyst in cardiac muscle. No other significant lesions noted.

Hematolological findings: Blood samples not collected as tubes and slides not available.

Clinical diagnosis: Normal, 3-year-old cow that died from respiratory failure following spraying with Dichlorvos (Vapona®).

5

Necropsy findings: Rumen contained several feet of rope. Lungs were emphysematous.

Histopathological findings: Sarcocyst in cardiac muscle. No other significant lesions noted.

Hematological findings: Blood samples not collected as tubes and slides not available.

Clinical diagnosis: Normal, 1-year-old, lactating cow that died from respiratory failure following spraying with Dichlorvos (Vapona®).

6

Necropsy findings: No gross lesions noted.

Histopathological findings: No significant lesions noted.

Hematological findings: Blood samples not collected as tubes and slides not available.

Clinical findings: Normal, newborn calf.

AREA 18 CATTLE, OCTOBER

7

Necropsy findings: A plaque was noted on cornea of left eye. No other gross lesions noted. Rumen contained alfalfa hay.

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7 (Continued)

Histopathological findings: Hepatocytes of liver moderately swollen, sarcocysts in cardiac muscle. The spleen showed moderate hemosiderin infiltration in the red pulp with numerous eosinophiles around the follicles.

Hematological findings‡: WBC/μl 5.5 x 10 ; Neutrophiles % 22; Lymphocytes % 60; Eosinophiles % 18; Hb g % 17.7; and Hematocrit % 46.

Clinical diagnosis: Normal, 11-year-old cow.

8

Necropsy findings: Rumen contained alfalfa hay. Actinobacillosis lesion on left maxilla, petechial hemorrhages and areas of emphysema in lung lobes that were due to agonal struggling.

Histopathological findings: Mild emphysema of lungs, sarcocyst in cardiac muscle, mild fatty changes in renal tubular epithelial cells, marked hemosiderin infiltration of pulp of spleen with increased eosinophiles.

Hematological findings: WBC/μl 4.7 x 10 ; Neutrophiles % 7; Lymphocytes % 80; Eosinophiles % 13; Hb g % 14.3; and Hematocrit % 39.

Clinical diagnosis: 6-year-old steer with actinobacillosis (lumpy jaw).

9

Necropsy findings: Right eye was opaque and had a penetrating wound with a purulent discharge. Rumen contained alfalfa hay. Three-month-old fetus in uterus, cirrhosis areas in liver, areas of atelectasis in lung.

Histopathological findings: Fatty changes in hepatocytes, spleen shows marked infiltration of hemosiderin with increased eosinophiles around follicles of white pulp. Alveoli hemorrhage in lungs from agonal struggling. Neoplastic squamous cell mass attached to cornea that appears to be undergoing immunological rejection.

Hematological findings: WBC/μl 3.6 x 10 ; Neutrophiles % 42; Lymphocytes % 52; Eosinophiles % 6; Hb g % 11.1; and Hematocrit % 32.
Clinical diagnosis: Pregnant, 11-year-old cow with squamous cell carcinoma of eye.

10

Necropsy findings: No gross lesions noted. Rumen contained alfalfa hay.

Histopathological findings: Eosinophiles surround many of the developing follicles of the spleen. Early spermatogenesis of testicle.

10 (Continued)

Hematological findings: WBC/µl 11 x 10^3; Neutrophiles % 19; Lymphocytes % 81; Hb g % 15.7; and Hematocrit % 43.

Clinical diagnosis: Normal 6-month-old bull calf.

11

Necropsy findings: Adhesions between diaphragm and reticulum, and between liver and reticulum. Rumen contained alfalfa hay.

Histopathological findings: Numerous eosinophiles were found near follicles of white pulp of spleen. No active spermatogenesis in testes. There is a chronic fibrosic mass attached to the Rumen mucosa.

Hematological findings: WBC/µl 6.4 x 10^3; Neutrophiles % 15; Lymphocytes % 75; Basophiles % 1; Eosinophiles % 9; Hb g % 14.9; and Hematocrit % 43.

Clinical diagnosis: Normal, 6-month-old bull calf with a circumscribed penetration through the reticulum.

12

Necropsy findings: Apical lobe of lung shows areas of atelectasis from agonal struggling. Alfalfa hay in rumen.

Histopathological findings: Hepatocytes swollen due to fatty change. Moderate number of eosinophiles are found in red pulp of spleen. No active spermatogenesis in testes.

Hematological findings: WBC/µl 11.3 x 10^3; Neutrophiles % 15; Lymphocytes % 80; Eosinophiles % 5; Hb g % 14.4; and Hematocrit % 40.

Clinical diagnosis: Normal, 6-month-old bull calf.

NEVADA TEST SITE MULE DEER

1

Necropsy findings: Both left legs fractured, left rib cage shattered with puncture wounds of the lobes of the left lung. Uterus contained twin male fawns one month from term. Samples not collected from hematological examination.

Histopathological findings: Sarcocyst in muscle, spleen and liver congested.

Clinical diagnosis: Normal, pregnant doe deer that died in collision with motor vehicle.

2

Samples were from fetuses from mule deer number 1. Normal on necropsy. Samples not collected for hematological and histopathological examinations.

3

Necropsy findings: Animal not necropsied as prosector not available. Samples not collected for histopathological or hematological examinations.

Clinical diagnosis: Apparently normal doe deer that died in collision with motor vehicle.

4

Necropsy findings: Multiple compound fractures of right foreleg and right ribs. Liver and rumen extensively traumatized. Histopathological and hematological samples not collected as were advance autolysis of tissues.

Clinical diagnosis: Normal, male deer that died in collision with motor vehicle.

5

Necropsy findings: Rumen had ruptured and ingesta was scattered throughout the peritoneal cavity. Lactating doe. Histopathological and hematological samples not collected as were advance autolysis of tissues.

Clinical diagnosis: Normal, lactating doe deer that died in collision with motor vehicle.

6

Necropsy findings: Multiple compound fractures of left rib cage and left foreleg. Liver was in several fragments, lungs were extensively traumatized by rib fragments. Rumen was ruptured and ingesta scattered throughout the peritoneal cavity. Hematological samples not collected.

Histopathological findings: Spleen congested with moderate amount of hemosiderin in the red pulp, sarcocysts in the muscle, mild emphysema of lungs, probably agonal. Focal infiltration of lymphocytes near the epicardial surface of the heart. Testicles show normal spermatogenesis.

Clinical diagnosis: Normal, male deer that died in collision with truck.

FERAL NEVADA TEST SITE HORSE

Necropsy findings: Compound fracture of left rear leg above hock joint, fractured skull and numerous lacerations and abrasions. Colon was ruptured

FERAL NEVADA TEST SITE HORSE (Continued)

with release of contents into peritoneal cavity. Autolysis of tissues was advanced. Sample not collected for hematological examination.

Histopathological findings: Mild emphysema of lungs, probably agonal. No other significant lesions noted.

Clinical diagnosis: Normal, feral, immature male horse that died in collision with truck.

NEVADA TEST SITE RABBITS AND CHUKAR

All of these animals were collected by shotgun fire. All were placed in a freezer until necropsied. No gross lesions were noted. All were apparently normal at time of death. Samples for histopathological or hematological examinations were not collected.

NEVADA TEST SITE GOLDEN EAGLES

1

Necropsy findings: Burns under each wing, round worms present in the intestine. Samples not collected for hematological or histopathological examinations.

Clinical diagnosis: Normal, adult golden eagle that was electrocuted.

2 and 3

Necropsy findings: Superficial burns on wings. Samples not collected for hematological or histopathological examination.

Clinical diagnosis: Normal, adult golden eagles that were electrocuted by short circuiting a power substation.

DESERT BIGHORN SHEEP

All of these animals were mature males that were killed by licensed hunters. No necropsies were performed but all were apparently normal at time of death. No samples were collected for histopathological or hematological examinations.

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(Please read Instructions on the reverse before completing)

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16. ABSTRACT Data are presented from the radioanalysis of tissues collected from cattle and wildlife that resided on or near the Nevada Test Site. Gamma-emitting radionuclides were detected infrequently with the exception of short-lived radionuclides found in samples from animals collected soon after a nuclear test by the People's Republic of China. Plutonium and Strontium-90 concentrations in tissues from deer, cattle, and desert bighorn sheep were consistent with those of recent years. Tritium concentrations were generally within expected environmental limits with the exception of animals exposed to sources of contamination. Radionuclide tissue concentrations were generally higher in the tissues of animals residing in Area 15 than in similar animals collected from other Nevada Test Site areas.

Hypothetical dose estimates to man were calculated on the basis of the daily consumption of 0.5 kilogram of liver or muscle from animals that contained peak radionuclide levels. The highest postulated dose was 1.4 millirems for tritium in tissues from a mule deer.

The movements of 13 mule deer outfitted with collars containing a radio transmitter unit were monitored on a weekly basis. During the winter deer left their summer range and migrated 40 to 60 kilometers south and west. A deer originally captured in 1977 was killed by hunters approximately 120 kilometers from its capture point.

No gross or microscopic lesions were found in necropsied animals that could be directly attributed to the effects of ionizing radiation.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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